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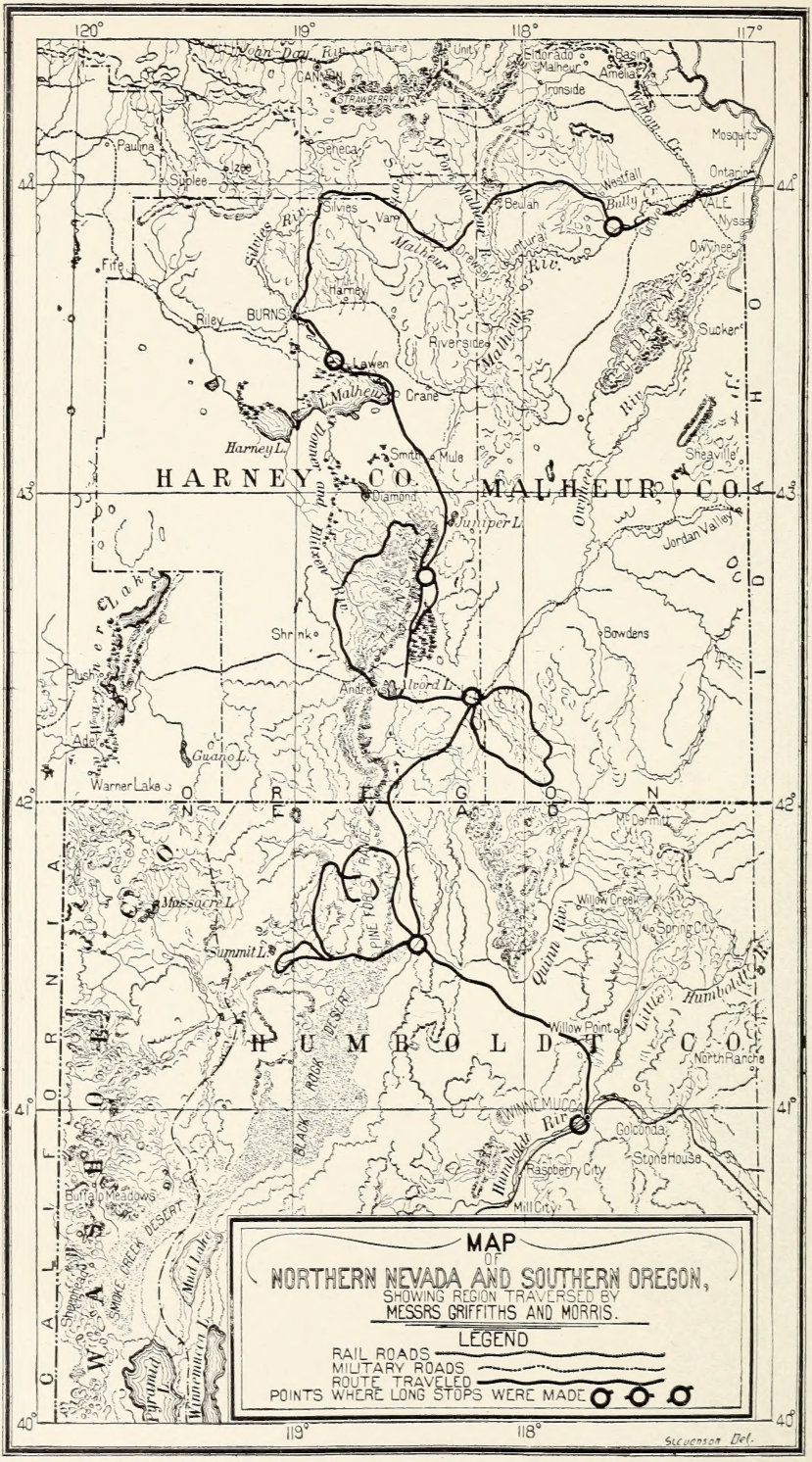
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Warner Lake
OREGON
NEVADA
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Massacre L.
Willow Creek
Spring City
Quinn River
Summit L.
Pine Forest Mts.
Little Humboldt R.
HUMBOLDT CO.
Willow Point
North Range
Black Rock Desert
Winnemucca
Golconda
Stone House
Raspberry City
Mill City
Humboldt R.
Smoke Creek Desert
Mud Lake
Pyramid L.
Honey Lake
CALIFORNIA
MAP
OF
NORTHERN NEVADA AND SOUTHERN OREGON,
SHOWING REGION TRAVERSED BY
MESSRS GRIFFITHS AND MORRIS.
LEGEND
RAIL ROADS
MILITARY ROADS
ROUTE TRAVELED
POINTS WHERE LONG STOPS WERE MADE
Stevenson Del.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 15.

B. T. GALLOWAY, Chief of Bureau.

FORAGE CONDITIONS ON THE NORTHERN BORDER OF THE GREAT BASIN,

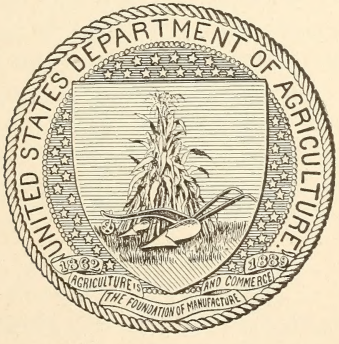
BEING A

REPORT UPON INVESTIGATIONS MADE DURING JULY AND AUGUST, 1901, IN THE REGION BETWEEN WINNEMUCCA, NEVADA, AND ONTARIO, OREGON.

BY

DAVID GRIFFITHS, EXPERT IN CHARGE OF FIELD MANAGEMENT,

GRASS AND FORAGE PLANT INVESTIGATIONS.



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1902.

LETTER OF TRANSMITTAL

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., December 1, 1901.

Sir: I have the honor to transmit herewith a paper on Forage Conditions on the Northern Border of the Great Basin, and respectfully recommend that it be published as Bulletin No. 15 of the Bureau series. The paper was prepared by Mr. David Griffiths, expert in charge of field management, Grass and Forage Plant Investigations, and was submitted by the Agrostologist.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

In July, 1901, Dr. David Griffiths, expert in charge of field management, accompanied by Mr. E. L. Morris, was commissioned to visit northern Nevada and southern Oregon to investigate the range conditions in that section, and the results of his observations are embodied in this bulletin.

Comparatively little was previously known as to the existing conditions in this region, and the present report shows the pressing need of reform in range management—a matter which applies not only to this section, but to all the open ranges in the West. Throughout the entire West, as the better land has been taken up by settlers the cattle and sheep ranges have become more restricted, and stock are now forced back from the fertile river bottoms and other lands so situated as to make irrigation possible, and the inevitable result has been overstocking of these restricted and poorer ranges, with all the attendant evils.

In pursuing his investigations Dr. Griffiths visited the Pine Forest, Bartlett Peak, Steins, White Horse, Blue, and Bendire mountains, the valleys of the Humboldt, Quinn, Silvies, and Malheur rivers, and the basins of the Alvord Desert and Malheur Lake, thereby traveling about 700 miles between July 17 and August 30. In furtherance of these investigations, Hon. J. P. Irish and Mr. John Gilcrest, superintendent of the Miller and Lux and the Pacific Live Stock companies' interests in Nevada and Oregon, furnished transportation, guides, and living expenses for the party for practically the entire trip from Winnemucca, Nev., to Ontario, Oreg.; and to both Mr. Irish and Mr. Gilcrest we are greatly indebted for courtesies shown during the trip. Acknowledgment is also here made to the Bureau of Soils of this Department for the analysis of soil samples collected on the trip.

F. Lamson-Scribner,
Agrostologist.

Grass and Forage Plant Investigations,
Washington, D. C., November 29, 1901.

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FORAGE CONDITIONS ON THE NORTHERN BORDER OF THE GREAT BASIN.

INTRODUCTION.

The area of our public grazing lands has decreased so steadily with the tide of westward emigration that the stock industry, which once flourished on the magnificent pastures of the public ranges, is now driven into situations either too arid or too rugged for the husbandman's use. From a natural tendency to increase rather than to diminish the number of stock has resulted a condition of shortage of feed, which was foretold years ago by those who were then studying the treatment of the ranges. This condition has awakened great activity in investigations of questions pertaining to the preservation of the feed supply of the public pasture lands. So numerous are the requests for information, advice, and suggestions for the improvement and management of the ranges which are received in the office of the Agrostologist that it is very difficult to give all of them the attention which they deserve.

In response to one of these requests the writer and Mr. E. L. Morris were commissioned to make a tour of a portion of the ranges of northern Nevada and southeastern Oregon for the purpose of determining the condition of the forage supply and ascertaining, if possible, some method of treatment of the range and pasture lands which would tend to increase the efficiency of the pastures and hay meadows.

A request from the secretary of the Eastern Wyoming Wool Growers' Association, that a representative of the office visit the midsummer meeting of that body for the purpose of addressing the members in attendance on range and forage plant problems, was received prior to our departure for the field. Arrangements were therefore made to attend the meeting of this association, held at Douglas, Wyo., July 10, 11, and 12 to give such information and advice as seemed best calculated to be of service to those in attendance and to acquaint them with the work of the office of the Agrostologist. The interest which naturally exists in forage and range problems was abundantly exhibited in the meetings and by the attitude of the members toward forage problems as they came before them. The programme itself exhibited this interest in no mistakable terms, for there were three places allotted

to addresses on the various phases of grass and forage problems and range reclamation by as many persons. The problems of greatest interest to the meeting appeared to be those relating to the most promising arid land species of forage plants, forage plants for alkali soils, and methods of range management having for their object the greatest permanent efficiency of the native pastures.

After the conclusion of the meeting at Douglas the party proceeded directly to Winnemucca, Nev., and began its work along the Humboldt River bottoms. The lines of investigation covered every phase of forage plant and range questions in the region, and necessitated work along about six lines, namely, studying the native ranges, securing information from the ranchers in the region relative to former conditions, collecting specimens, gathering seed of promising native species of forage plants, digging soil samples, and taking photographs illustrating the various features of the work.

After a few days' work on the Humboldt River bottoms in the vicinity of Winnemucca, the party started northward, making several short stops before reaching Quinn River crossing, 75 miles to the northwest. Here we made our headquarters until the 1st of August. Being a representative and rather favorable locality, we found an abundance of very interesting and profitable work. From here we outfitted for a trip to the ranches surrounding the Pine Forest Mountains, all of which are known locally as part of the "Quinn River outfit," stopping en route at the ranches known as Big Creek, Alder Creek, and Leonard Creek. From Alder Creek a trip was taken into the Pine Forest Mountains, and from Leonard Creek into the mountains in the vicinity of Summit Lake and Bartlett Peak, both under the guidance of Mr. Robert Bowling.

On the 1st of August we crossed the Nevada-Oregon line at Denio and the next day reached the White Horse Ranch, near the site of old Fort Smith. Work was confined here to hay and pasture meadows and to a two days' trip into the White Horse Mountains, a low range forming the watershed between the Quinn River and the Alvord drainages. Our route was along the divide skirting the headwaters of Willow, Cottonwood, and White Horse creeks. The next stop was made at the Wild Horse Ranch, near Andrews. This property is but little improved and therefore affords an excellent opportunity for studying the condition of the native meadows of the region. Here we secured a pack outfit, consisting of three saddle horses and two mules, for a trip into Steins Mountains, under the guidance of Mr. Joe Bankofier. A special effort was made to traverse the region known as the summer range, where the greatest number of stock is usually found at this time of the year. The mountains were ascended from the Wild Horse side by the trail leading to Ankle Camp, a round-up station in the

mountains. From here on until within a few miles of Manns Lake there was practically no trail, except such as had been made here and there by cattle and sheep traveling to and from water and feed. In no case did we reach the highest elevation on the mountains, but skirted them on the west and north along the broad broken table-lands where so much pasturing is done. Our course led across and somewhat below the sources of the Blitzen, Mud, Indian, and Cocoamongo creeks. From Manns Lake we returned to Wild Horse along the traveled road between the Alvord Desert and the base of the mountains, having in this manner surrounded the main divide of Steins Mountains and having traversed the main summer range of the region, accomplishing in this mountain range a similar survey of the country as we did in the Pine Forest and adjacent ranges in northern Nevada. Returning from Wild Horse to Manns Lake, a couple of days were spent in the vicinity of Divine's ranch, which extends from the eastern slope of Steins Mountains to the Alvord Desert. The next stop of any length of time was made on the Island Ranch, between the forks of Silvies River, 15 miles south of Burns. From here we traveled by rather rapid stages to Ontario, passing en route Silvies, Calamity Settlement, Drewsey, Beulah, Westfall, and Vail. Short stops of one to three days were made near Silvies and Beulah, and at Indian Creek and Harper ranches.

For some features of the work conditions were not at all favorable. The region should have been visited about twenty days earlier for the collection of specimens. Many important things on the desert were so far gone when we arrived that good specimens could not be obtained; but, while there was loss in this respect, we were able to secure a large quantity of seed, especially of the valuable wild wheat (*Elymus triticoides*); and we were in just the right time for the study of the native hay meadows and the summer mountain pastures under full stocking.

The trip under the circumstances was very easily made, and was devoid of the many hardships which are usually encountered, even in regions much more easily traveled. This was due entirely to the excellent provisions made for our accommodation. The traveling was done by team, except when we took pack outfits on mountain trips. (See Pls. I, fig. 2; II, fig. 2; III, figs. 1 and 2, and IV, fig. 1.) During nearly the entire six weeks we received accommodations at ranches lying along the route. Sometimes the stops were made at a ranch; at other times with the hay crews on the meadows, and in one instance with a round-up outfit that was gathering beef for the market. A total of about 700 miles was covered in this manner, through probably the most sparsely populated and one of the largest areas in the country, with no railroads or telegraphic communication.

DESCRIPTION OF THE REGION.

The greater portion of the area studied is situated in the Great Basin, and may be briefly and tersely described as a series of basins along the border of this large arid region, which receives less than 10 inches of moisture during the entire twelve months.

As would be expected, the transition from the Great Basin to the headwaters of the Columbia River is a very slow and gradual one, and the remarks which follow, while dealing especially with the portion of the Great Basin visited, apply in general to that portion of the Columbia River drainage which lies contiguous to it on the north. The main basins visited were the Alvoid Desert and the basin of the Malheur and Harney lakes. A glance at the map will show that even the river valleys are in effect basins, for they almost invariably empty into "sinks" (broad, level areas) over which their waters spread and evaporate early in the summer, leaving a broad expanse of grayish white soil with no vegetation and often deeply fissured, as shown in the lower portion of Pl. VII, fig. 1. The Quinn River Valley is simply a portion of the large Black Rock Desert basin, and a section of it in the vicinity of Quinn River Crossing does not differ materially from a similar section of the basin of the Alvord Desert.

These level desert bottoms receive considerable water in the spring of the year from melting snows on surrounding mountains. The Alvord Desert, it is said, is usually a lake varying from a few inches to a foot or two in depth at this season, the depth varying greatly, however, from day to day in the different portions of the bed, depending upon the direction and velocity of the wind. Surrounding these areas, many of which are entirely devoid of vegetation during the entire year, while others less pronounced have scattering growths of iodine weed (*Spirostachys occidentalis*) and scattering bunches of greasewood (*Sarcobatus vermiculatus*), is found a zone of greater or less extent—a few feet to several rods or even a mile in some cases—of salt grass (*Distichlis spicata*). Beyond this the greasewood again predominates, but often gives place in certain localities to the rayless goldenrod—the rabbit brush of the region (*Chrysothamnus graveolens*). Beyond the greasewood belt the soil is less alkaline, as shown by the presence of the black sage (*Artemisia tridentata*), which extends from here through the ravines and other depressions up into the mountains. On the lower foothills between the ravines, in which the black sage is the characteristic plant, the spiny saltbush (*Atriplex confertifolia*), hop sage (*Grayia spinosa*), and bud sage (*Artemisia spinescens*) are usually the conspicuous plants, especially in northern Nevada. The latter are less conspicuous to the northward. Indeed, we saw but very little of the three last named after leaving the Alvoid Desert until we reached the main stream of the Malheur River near the Harper Ranch, 40 miles above Ontario, Oreg.

FIG. 1.—CATTLE RANGE IN BENDIRE MOUNTAINS, OREGON.

Blue grass, fescue, and black sage in foreground and a few junipers in the distance.

FIG. 2.—DESERT VIEW NEAR DENIO, OREGON.

Black sage, bud sage, spiny saltbush, rayless goldenrod, and hop sage shown.

PRECIPITATION RECORD FOR 1900 AND 1901.

In common with the entire Great Basin area the precipitation is very meager and occurs mainly during the winter months. The following table, kindly furnished by the United States Weather Bureau, shows for Winnemucca, Nev., and Burns, Oreg., a total precipitation of less than 7½ inches for the entire twelve months of the year 1900:

Precipitation for Nevada and Oregon.

	Nevada.				Oregon.	
	Winnemucca.		Quinn River Crossing.		Burns.	
	1900.	1901.	1900.[a]	1901.	1900.	1901.
January	0.71	1.31	.....	.....	Trace.	1.20
February	.69	1.87	.....	2.68	1.80	1.67
March	.47	.16	.....	.26	.54	.30
April	.96	.78	.....	.60	1.15	.34
May	1.47	.73	.....	.19	.34	.12
June	.12	.05	.....	.12	.34	.15
July	.04	Trace.	.....	.00	.00	.00
August	Trace.	1.16	.....	.24	.17	.22
September	.22	.....	.....	.....	.24	.....
October	.74	.....	.....	.....	.62	.....
November	1.89	.....	.....	.....	.47	.....
December	.12	.....	.....	.....	.90	.....
Annual	7.43	.....	.....	.....	6.57	.....

[a] No record prior to February, 1901.

It is to be understood, of course, that the observations on precipitation are made on the lowlands. The higher levels receive much more moisture, or else the region would be a desert indeed. Observations taken on the summer range on Steins Mountains would be very instructive and show without doubt a greater precipitation for some months than for the entire year at Winnemucca or Quinn River Crossing. It is the low ranges of mountains surrounding the basins that enable the country to support even a sparse population.

The mountains for the most part are low, under 9,000 feet in altitude, and thinly wooded. A very prominent characteristic of the three ranges visited south of Burns—Pine Forest, White Horse, and Steins Mountains—is the presence of numerous narrow, steep ravines and gorges bordered by often impassable rim-rocks, and a slope to the northwest much more gentle and prolonged than that to the southeast. Indeed, the White Horse Mountains, especially, present the appearance of a huge fault which has subsequently been cut out by the action of water until there occurs a long, gentle slope, fissured by narrow ravines with very precipitous sides and bordered by perpendicular cliffs of rim-rocks.

Another very striking peculiarity which one used to Rocky Mountain areas notices immediately is the abundance of small springs which

furnish but little water. This, however, is to be expected in such small and low mountain ranges. Not only does the water of Nevada not reach the ocean, but the rivers do not reach the sinks, and the small tributaries from the mountains often do not reach the main channel, for all of the water that succeeds in getting down to the fertile sage-brush areas near the river bottoms is used at the present time in irrigation. The rivers reach the sinks in the spring; the brooks, the rivers in early summer; but even the rivulets close to the base of the mountains are dry in summer or early autumn. On the advent of cool weather in the fall the waters are said to "rise" whether it rains or not. Even the diurnal fluctuation in the mountain brooks is often remarkable. One may find a brook carrying a considerable volume of water in the morning but have none whatever at 5 o'clock in the afternoon. By the next morning it will have regained its usual volume. This was unusually conspicuous on the eastern side of Steins Mountains at the Divine and Manns Lake ranches, where observations were conducted for several days.

The only range containing pine timber south of the spur of the Blue Mountains, north of Burns, Oreg., was the Pine Forest Range near Quinn River Crossing. Here on the highest elevations is a scanty growth of pine (*Pinus albicaulis*). It is rather astonishing that we should find this isolated range having pine timber upon it, while neighboring ones, such as Steins Mountains, have no pine at all. The latter, however, have a much larger quantity of Juniper (*Juniperus virginiana*) than the former. The latter are also said to contain some balsam in one or two of the canyons, but we found none upon our route. The principal pine in the spur of the Blue Mountains which we crossed north of Burns is the bull pine (*Pinus scopulorum*). The best growth of juniper seen on the whole trip was in Steins Mountains. Even here, however, there is seldom what one may term a forest, but on the contrary, scattering trees, 10 to 18 inches in diameter are found at long intervals. Aside from the pines and juniper, the only trees of the region south of Burns are two species of poplar (*Populus tremuloides* and *P. trichocarpa*). The latter is quite abundant in canyons and deep ravines in Steins Mountains, but the former species is the important one in the other ranges visited, both in the gulches and on the high shaded slopes. Among other shrubby plants which form dense thickets, often over areas of considerable extent, may be mentioned: Mahogany (*Cercocarpus ledifolius*), service-berry (*Amelanchier alnifolia*), snow brush (*Ceanothus velutinus*), spirea (*Holodiscus dumosus*), Indian currant (*Symphoricarpos oreophilus*), shrubby cinquefoil (*Dasiphora fruticosa*), and choke-cherry (*Prunus emarginatus* and *Prunus demissa*). Along the moister areas in gulches one always finds a profuse growth of willows which are also sometimes found forming thickets on high, moist, shady slopes. In the same localities extensive growths of alder are also to be found. The willows of the entire

FIG. 1.—MOUNTAIN PASTURE IN BLUE MOUNTAINS ALONG CALAMITY CREEK, OREGON.

FIG. 2.—BLACK SAGE ON MALHEUR RIVER NEAR VALE, OREGON.

region are nearly all small and shrubby. They are seldom large enough for posts but are often used as stays and to a large extent in building corrals.

To casual observation the desert regions are very different from those of southern Arizona. There is a very noticeable absence of the creosote bush and the various species of *Cactaceæ*, their place being taken by the spiny salt bush (*Atriplex confertifolia*), bud sage (*Artemisia spinescens*), and black sage (*Artemisia tridentata*). Close examination, however, reveals many striking similarities. The preponderance of small animals belonging to the reptilian type, as well as the remains of an ephemeral spring vegetation, remind one of the southern deserts. This spring vegetation, which was recognizable at the time of our visit, belongs largely to the phlox, mustard, and borage families and apparently to the botanical genera *Gilia*, *Sisymbrium*, *Amsinkia*, and *Eritrichium*, a list which corresponds very closely, as far as it goes, with the conspicuous fugacious spring plants of the Arizona deserts.

THE SOILS.

An effort was made to learn as much as possible concerning the relation of the soluble salts in the soil to the development of forage crops both native and cultivated. Fifty soil samples were gathered, but owing to lack of time for their study only twenty-four were selected for analysis. A comparison of the description of the samples with the table of analyses will show that the selection was made with special reference to certain forage crops. The analyses are of value, therefore, in indicating the kind of soil upon which the best native forage plants grow, and suggest what may be expected of such areas when an attempt is made to bring them under cultivation. In a few instances analyses of soils which have baffled attempts at seeding with cultivated crops, especially alfalfa, are given. Some of the failures reported and observed are evidently due to too much soluble salts in the soil, while others are directly traceable to improper application of irrigation water.

DESCRIPTION OF SOIL SAMPLES.

No. 1.—July 16, on Humboldt River, 3 miles below Winnemucca, Nev. Deep, productive river-bottom soil, which bakes very hard when dry. It is this soil which produces fine crops of wild wheat or blue stem (*Elymus triticoides*). It is evidently very fertile, and when properly irrigated yields immense crops of hay. The sample was wet when collected, and was taken from a typical locality from which was being cut 2 tons of hay per acre.

No. 3.—July 19, near "Dutch John ranch," Quinn River Valley, Nev. Greasewood (*Sarcobatus vermiculatus*) soil which bakes very hard when dry. Probably very alkaline, but this had no crust. Large areas in this vicinity are covered with water during a portion of the winter and early spring.

No. 4.—July 21, Quinn River Crossing, Nev. Salt grass land, crusty and exceedingly hard. The crust is easily broken, rather thin and seldom white. Below this is a layer of rather mellow soil subtended by a hardpan. The crust is about one-eighth of an inch in thickness, mellow soil one-half inch and hardpan indefinite.

No. 8.—July 21, 1901, Quinn River Crossing, Nev. Giant rye-grass (*Elymus condensatus*) soil, so hard at this time of the year that it is almost impossible to penetrate it with a trowel. This sample is from the typical open areas on the Quinn River bottoms near the Miller and Lux ranch, and differs very materially from the soil which produces equally large quantities of this grass in sage-brush areas. The meadow from which this sample was taken is heavily pastured during the winter months.

No. 11.—July, 1901, near Leonard Creek ranch, about 85 miles northwest of Winnemucca, Nev. There was practically nothing growing where this sample was taken except Nuttall's saltbush (*Atriplex nuttallii*) and white sage (*Eurotia lanata*). The sample was taken from a small basin-shaped depression about 20 rods in diameter. It has a very different appearance from the typical white sage soil of the region, the latter usually growing on well-drained slopes with the spiny saltbush (*Atriplex confertifolia*).

No. 13.—July, 1901, Alder Creek ranch, about 100 miles northwest of Winnemucca, Nev., and at the western base of the Pine Forest Mountains. Meadow soil in which Nebraska sedge (*Carex nebraskensis*) grew to the exclusion of all other vegetation. This sedge invariably grows in low depressions which are flooded for a large part of the year.

No. 16.—August 1, 1901, in Nevada, near Denio, Oreg. This is considered to be the typical soil upon which this rayless goldenrod (*Chrysothamnus graveolens*) is usually found. There were but very few other shrubs or other vegetation of any kind growing where the sample was taken.

No. 17.—August 2, 1901, near Denio, Oreg. Sample taken from what appeared to be a very alkaline situation covered with a good stand of alkali saccaton (*Sporobolus airoides*).

No. 18.—August 2, 1901, near Denio, Oreg. Sample from one of the rather sandy areas surrounding and situated above the bottom of the valley. The vegetation consists of black sage (*Artemisia tridentata*), bud sage (*Artemisia spinescens*), spiny saltbush (*Atriplex confertifolia*), hop sage (*Grayia spinosa*), and rayless goldenrod (*Chrysothamnus viscidiflorus*). It is unusual to find these plants growing in this way. They are usually more or less separated and grow on different soils. It is common to find two or three of them together, but the writer has never seen them growing so intimately mixed anywhere else.

No. 22.—August 6, 1901, Alvord Desert, Oregon. This is what is known in the region as "self-raising ground." It presents a peculiar appearance, inasmuch as the soil blisters and is mellow on top, while the subsoil may be moist, as was the case where this sample was taken, or it may be exceedingly hard when it becomes dried out. No salt was visible where this sample was taken, neither was there any vegetation of any kind. The soil is covered in late winter and early spring with about 6 inches of water. This evaporates early in the season, when the ground becomes dry, hard, and fissured.

No. 23.—August 6, 1901, on the Wild Horse Ranch, near Andrews, Oreg. The sample was taken from the center of a large area of salt grass (*Distichlis spicata*). The soil is very hard but has no salt visible upon it. The grass in this locality was covered with a gummy, acid secretion. This does not appear on the base of the culms near the ground, but on the upper, green, and vegetative portion of the plant. It is a very peculiar characteristic of salt grass over large areas in eastern Oregon. It was met with first in small areas at Quinn River Crossing, Nev., and was subsequently observed at Divine's ranch on the edge of the Alvord Desert, and also on the Malheur Lake bottom south of Burns. The secretion has a gummy, sticky consistency under ordinary temperatures, but during hot weather, when the samples were collected, it deliquesced very readily when carried in a vasculum. The presence of the secretion is very noticeable the moment one attempts to walk through an area of grass covered with it, on account of the impediment which it offers. One's clothing soon becomes covered with the gummy substance. The areas upon which it

appears, while often very large, have quite definite boundaries, and one area may be entirely free from this secretion while another in close proximity may contain large quantities of it. No difference was observed between soil characteristics of the affected and unaffected areas. The largest quantity of deposit and the largest extent of grass affected was on the meadows near Andrews, Oreg.

No. 24.—August 7, 1901, Wild Horse Ranch, near Andrews, Oreg. Garden soil irrigated from a spring of pure water,[a] located on an alkali knoll, which produced nothing but salt grass. The garden was located about 10 feet lower than the spring. A black crust is often seen on the ground and along the ditches, but in spite of this strongly alkaline appearance good vegetables, potatoes, onions, and beets were raised on the soil.

No. 25.—August 7, 1901, Wild Horse Ranch, near Andrews, Oreg. This is a sample of a black deposit from the edges of the irrigating ditch carrying water spoken of in sample 24. A black crusty deposit appears all along the ditches.[a]

No. 26.—August 7, 1901, Wild Horse Ranch, near Andrews, Oreg. Soil from which this sample was taken contained a very conspicuous growth of rayless goldenrod (*Chrysothamnus graveolens*) with alkali grass (*Puccinellia airoides*) and salt grass (*Distichlis spicata*) covering from two-thirds to three-fourths of the ground between the bushes.

No. 29.—August 13, 1901, Divine's ranch, 15 miles northeast of Andrews, Oreg. Sample is from the lowlands, some distance from the Alvord Desert. Vegetation where sample was taken consists of small cord grass (*Spartina gracilis*) and some salt grass (*Distichlis spicata*). There was a slight crust of salt on the surface.

No. 32.—August 13, 1901, near Divine's ranch, on swamp meadow belonging to Manns Lake Ranch, about 20 miles northeast of Andrews, Oreg. There was no vegetation where the sample was taken. There was a thick (one-fourth of an inch) blistery crust of white or sometimes yellowish salt on the surface. The soil below this was black or brown-black, pasty and moist. It was of the consistency of putty and situated some distance from a small greasewood area on a swamp meadow. A small packet of surface salt is included.

No. 33.—August 13, 1901, near Divine's ranch, about 20 miles northeast of Andrews, Oreg., on a swamp meadow belonging to Manns Lake Ranch. This soil produced from 2 to 2½ tons of hay per acre of prairie bulrush (*Scirpus campestris*). It was very hard, dry, and badly cracked (Pl. VII, fig. 1). This sample was taken within 15 yards of sample No. 32. There was a narrow strip, 4 or 5 feet wide, of salt grass intervening between the bare area where No. 32 was taken and this fine growth of the bulrush.

No. 34.—August 14, 1901, Juniper Ranch, about 20 miles north of Manns Lake, Oreg. Boggy, sedgy, meadow soil, very characteristic over large areas in this region. Two or three species of sedges, a little clover, and moss constitute the principal vegetation.

No. 38.—August 15, 1901, Malheur Lake bottoms, near Windy Point, Oreg. The sample is from one of the large squirrel tail grass (*Hordeum jubatum*) areas so characteristic on the open range to the east and north of the lake. The soil is porous, dark in color, and has the appearance of being rich and productive. It is usually slightly lower than the surrounding salt grass areas and is often spotted or even covered with a dense growth of rayless golden rod, with which the squirrel tail grass is mixed. Where the sample was taken there was no vegetation but squirrel tail grass.

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[a] Analysis of a sample of the water subsequently furnished by Foreman Arthur Barnes verifies this statement, there being but 19.3 parts solids per 100,000. The alkali along the ditches was evidently from the soil between the spring and the cultivated area.

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No. 40.—August 17, 1901, Malheur Lake bottoms, Island Ranch, about 15 miles south of Burns, Oreg. Soil where awned sedge (*Carex aristata*) grew to the exclusion of all other vegetation. This appears to be rich soil, and certainly produces magnificent crops of this important forage plant.

No. 41.—August 17, 1901, Malheur Lake bottoms, Island Ranch, about 15 miles south of Burns, Oreg. The soil from which this sample was taken produced in restricted areas a ton to a ton and a half per acre of yellow top (*Calamagrostis hyperborea americana*). The localities in which this grows are usually well drained, and occur on slight elevations immediately surrounding the depressions where water remains until about the middle of July.

No. 43.—August 22, 1901, Agency Ranch, on North Fork of Malheur River, near Beulah, Oreg. Meadow soil, where alfalfa, timothy, and redtop sown last spring have made a fine growth. (See next sample.)

No. 44.—August 22, 1901, Agency Ranch, on North Fork of Malheur River, near Beulah, Oreg. The soil where this sample was taken differed but little in appearance from the previous one, but it contained no forage plants, and the seeds sown last spring failed to grow. This meadow is the most spotted one seen, although similar conditions on less extensive areas are frequent. Small areas with good stands of timothy, redtop, and alfalfa are common, while a few feet away there is nothing to be found but a weedy development of a couple of the annual saltbushes, mainly *Atriplex truncata*, and one of the western blights (*Dondia depressa erecta*). In some places there is a little salt visible on the surface of the bare or weedy areas, but the subsoil, to all appearances at least, is precisely the same as that which a few feet away produces a good stand of the forage plants sown.

No. 50.—August 23, 1901, Harper Ranch, on Malheur River, 40 miles above Ontario, Oreg. The field from which this sample was taken was sown last spring to alfalfa. Over the greater portion of it a fine stand was secured, but in one corner, which was considerably lower than the remainder of the field, water collected from the two irrigations which it received. There was no alfalfa whatever here, but a fine volunteer crop of barnyard grass (*Panicum crus-galli*) appeared instead. (Pl. XVI, fig. 1.) This volunteer crop would yield about 2 tons of dry feed per acre.

PARTIAL ANALYSES OF SOIL SAMPLES.

The following table of analyses of the samples of soils collected on the trip and the remarks thereon were kindly furnished by the Bureau of Soils of this Department:

Partial analyses of soil samples.

Number of sample.	Per cent soluble in water.	Carbonate (CO_3).	Bicarbonate (HCO_3).	Chlorids (Cl).	Sulphates (SO_4).	Phosphates (PO_4).	Nitrates (NO_3).	Borates (B_2O_7).	Carbonate of lime in soil.	Remarks.
1	0.13	.....	.....	.....	.....	.....	.....	.....	Small amount.	Not harmful amount of salts.
3	4.00	0.00	0.07	0.31	2.41	Trace.	0.00	0.00	.....	Sulphates (white alkali).
4	3.00	.19	.26	.76	.16	0.07	.00	.00	.....	Carbonates and chlorides (black alkali).
8	.04	.....	.....	.....	.....	.....	.00	.00	None	Not harmful amount of salts.
11	.06	.....	.....	.....	.....	.....	.00	.00	Small amount.	Do.
13	.03	.....	.....	.....	.....	.....	.00	.00	None	Do.
16	.08	.....	.....	.....	.....	.....	.00	.00	Small amount.	Do.
17	4.50	.00	.06	.37	3.28	Trace.	Trace.	.00	None	Sulphates (white alkali).

Partial analyses of soil samples—Continued.

Number of sample.	Per cent soluble in water.	Carbonate (CO_3).	Bicarbonate (HCO_3).	Chlorids (Cl).	Sulphates (SO_4).	Phosphates (PO_4).	Nitrates (NO_3).	Borates (B_4O_7).	Carbonate of lime in soil.	Remarks.
18	0.02	.....	.....	.....	.....	.....	0.00	0.00	None	Not harmful amount of salts.
18[1]	.03	.....	.....	.....	.....	.....	.00	.00	.....do	Do.
18[2]	.05	.....	.....	.....	.....	.....	.00	.00	.....do	Do.
22	4.00	0.20	0.50	1.62	0.19	0.07	.00	.00	Large amount.	Carbonates and chlorids (black alkali).
23	.60	.14	.17	.03	.02	.04	.00	.00	.....do	Carbonates (black alkali).
24	.13	.....	.....	.....	.....	.....	.00	.00	Small amount.	Not harmful amounts of salts.
25	1.60	.36	.46	Trace.	.01	.03	.00	.00	.....do	Carbonates (black alkali).
26	.52	.12	.24	.03	.04	.04	.00	.00	Large amount.	Do.
29	.50	.11	.14	.02	.04	.00	.00	.00	.....do	Do.
32	2.20	.48	.29	.02	.28	.08	.00	.00	.....do	Carbonates and sulphates.
32½	Crust.	16.19	28.46	1.05	12.75	.18	.00	Trace	.....do	Do.
33	.70	.12	.39	.03	.21	Trace.	.00	.00	.....do	Do.
34	.16	.00	.12	.02	.01	Trace.	.00	.00	None	Not harmful amounts of salts.
38	.35	.00	.27	Trace.	.02	Trace.	Trace.	.00	Large amount.	Do.
40	.14	.....	.....	.....	.....	.....	.....	.....	.....do	Do.
41	.35	.00	.25	.01	.02	.04	Trace.	.00	.....do	Do.
43	.25	.00	.19	.00	.01	.00	.00	.00	Small amount.	Do.
44	.50	.03	.36	.03	.02	.07	Trace.	.00	.....do	Carbonates (black alkali).
50	.25	.00	.18	Trace.	.03	Trace.	.00	.00	.....do	Not harmful amount of salts.

Only partial analyses are given, since they are sufficient to determine the kind and nature of the soluble salts.

The analyses of the water soluble component were made according to the conventional formula adopted by the Bureau of Soils: that is, to analyze the portion taken out of a soil by water, when the soil is kept in contact with twenty times its weight of water until equilibrium has been reached.

It has been found in the experience of the field parties of the Bureau of Soils that 0.6 per cent of soluble salts is a dangerous amount in a soil if there be no carbonates present. When soluble carbonates are present, 0.4 per cent may be regarded as the limit of endurance for cultivable crops. These limits have been established by the use of the bridge or field method for determining soluble material in the soil. The method of leaching, such as has been used in the accompanying analyses, will frequently give higher figures than those stated above as the limiting values for cultivable plants.

It appears from Mr. Griffiths' notes, together with these analyses, that salt grass (*Distichlis spicata*) is a black alkali plant. This bears out former observations and work of the staff of the Bureau of Soils.

The analyses show that several very important native forage plants grow on soil which is decidedly alkaline and which would in all probability not be easily brought under cultivation. The use of native species of plants as indicators of fertility of soil is recognized by all ranchers in a general way. This, however, is more especially true of the black sage than of any other plant. It is universally recognized that soils which produce luxuriant growths of this shrub are fertile and are especially well adapted for the cultivation of alfalfa, the main crop of the region. On the contrary, grease-wood soil is seldom cleared up and cultivated. When, however, it is desirable to bring the latter under cultivation, it is said that timothy is the most certain crop, and

that it thrives best on such soil with frequent light irrigations rather than with large amounts of water at infrequent intervals, as is usually applied to alfalfa.

The analyses of samples 43, 44, and 50 are especially instructive. It will be seen that sample 43, taken where seed germinated well, and sample 44, where it failed entirely, although only 15 feet apart, differ considerably in the amount of soluble salts which they contain. This difference, although only 0.25 per cent, is sufficient to place sample 44 in the class of soils containing dangerous amounts of alkali. This analysis also shows, as far as the analysis of a single sample can, that there is no appreciable difference between the resistant powers of alfalfa and timothy, although, as stated above, there is a popular belief that such is the case. Further investigations along this line would be profitable. Sample 50, on the contrary, does not appear to contain soluble salts in harmful amounts, although a stand of alfalfa was not secured on the land last spring. The failure here appeared to be due, as was suspected, to improper drainage.

FORAGE PLANTS GROWING ON ALKALINE SOILS.

The following table contains a condensed list of those forage plants which were found growing in soils containing soluble salts in quantities sufficient to be deleterious or dangerous to cultivated crops:

Forage plants growing in alkaline soils.

Number of soil sample.	Name of plant.	Per cent of soluble salt.	Kind of alkali.
3	Grease wood (Sarcobatus vermiculatus)	4.00	White.
4	Salt grass (Distichlis spicata)	3.00	Black.
17	Alkali saccaton (Sporobolus airoides)	4.50	White.
23	Salt grass (Distichlis spicata)	.60	Black.
26	Alkali grass (Puccinellia airoides)	.52	Do.
29	Small cord grass (Spartina gracilis)	.50	Do.
33	Prairie bulrush (Scirpus campestris)	.70	Do.
44	Utah saltbush (Atriplex truncata)	.50	Do.

HANDLING OF STOCK.

As is inevitably the case in all open-range stock raising, the methods of operation are rapidly changing. Where a few years ago cattle were almost unprovided for during the entire winter and were taken from the range directly to the eastern markets, they are now fed from two to four months of the year and are almost invariably fattened before being slaughtered. This change is being brought about by two causes which are very intimately related to each other. The persistent home seeker has explored these vast areas and taken up land under his rights as a citizen wherever a favorable spot appeared. At the present time the tillable areas where water is convenient and, therefore, under conditions of nature the most productive in the unim-

FIG. 1.—GRAZED NUTTALL'S SALTBUSH, WESTFALL, OREGON.
No other vegetation shown in foreground except one bunch of cactus.

FIG. 2.—BLACK SAGE (ARTEMISIA RIGIDA) GRAZED, WESTFALL, OREGON.
Common black sage (Artemisia tridentata) in background.

proved condition, have been made the bases for ranches. These favorable areas have consequently been cut out of the general range source of supply. The second cause is dependent upon the first and results from the overstocking of the range, giving the cattle but little to feed upon during the winter. They therefore must have provision made for them. In portions of Montana, Wyoming, and western South Dakota it is customary to fence large areas of land on the general mesa or prairie in order to protect the range until winter sets in. No hay is cut in these fenced fields. The grass simply dries up in the fall and the cattle graze it during the winter. In northern Nevada and southeastern Oregon, however, the fenced areas occur on the bottom lands, and they are made to serve the double purpose of furnishing a crop of hay during the summer and pasturage during the winter. Indeed, many of these fields were being pastured while we were in the region in August. But more will be said concerning this later. The reason for this difference in the use of the pastures in the two regions is a simple one and results from local and natural conditions. The mountain regions as a whole are unsuitable to winter pasturing, and the desert mesa in this region furnishes so little feed that it scarcely pays to fence and protect it during the summer. The only available sources of pasturage during the winter, therefore, are the bottom lands. They are also the only available native hay lands, and are therefore forced to furnish both winter pasturage and hay. The result of this double drain upon the land is too well known to need any extensive comments. The result is just what one would expect—both the pasture and the hay crop are rendered inferior by such treatment.

According to information received from ranchers scattered all the way from Winnemucca to Ontario, the feeding season begins about the 1st of December and continues until the last of March. During the remainder of the season the cattle "rustle" their living. Full feeding, however, does not begin until after Christmas. From this time on about two-thirds of the cattle receive a full ration of hay, the remaining third finding their own living in the lowland pastures among the tule (*Scirpus lacustris*) and willows and in other localities where it was impossible or unprofitable to run a mower during the previous summer. Of course, there is some growth of grass on the meadows which were cut, and this also is pastured down closely. In this way all cattle are provided for during the winter. They are either pastured in the fields or fed hay, as their condition appears to demand. Usually the steers and dry cows "rustle" for themselves in these pastures; but the majority of the cows and all the calves are fed, the pasture herd being continually worked over during the winter, for the purpose of selecting those that need more feed than they are able to secure in the meadows.

Sheep are usually wintered on the desert. They feed at this season to a very large extent on desert shrubbery. Being able to subsist on this kind of a ration better than cattle, renders them much more easily provided for. Indeed, as near as we were able to learn from the herders and ranchers, sheep receive hay for from only two to four weeks through the entire winter in the southern portion of the area traversed. Being able to subsist on even the black sage (*Artemisia tridentata*) for a few days, they are much less subject to loss during a season of severe weather, especially as they have a herder with them constantly, who is able to move them from place to place and thus secure the best feed available. One man usually takes care of from 2,000 to 3,000 sheep. One herder in the White Horse Mountains informed us that his flock was never fed over two weeks during the winter; others placed the feeding period at four weeks, while we were informed at Ontario that in that vicinity they were often fed some hay for two months.

The summer feed of both cattle and sheep is obtained from the open range on the foothills and mountains. The sheep wintered on the deserts begin to move upward as soon as the vegetation appears in the spring. They follow the development of the green feed from the foothills up to the snowdrifts, and finally work their way down again by easy stages when autumnal storms begin to threaten. The sheep, being close-herded, clear the ground over which they pass of vegetation much more closely than the cattle which run at large with practically no care, and consequently scatter in small herds of six to twelve animals. This, together with the fact that sheep eat plants that cattle will not, constitutes the main distinction between the effect of cattle and sheep on range pastures. If allowed to run at large as cattle do, and consequently scatter in small flocks, as they naturally would, the evil effect of absolutely cleaning off large areas by close grazing, and the pulverizing of extensive tracts of ground in the region where they tramp in closely packed herds during the heat of the day, and still more effectively in the bedding-down places at night, would be largely overcome. But this method of handling sheep could not of course be practiced because of the presence of dogs and wild animals which would in a short time exterminate the flocks.

The cattle, although allowed to run at large, are looked after to some extent during the summer. They also are kept in the mountains as much as possible. When they return to the lowlands, where they were fed during the previous winter, either on account of short feed or the sheep herder's dog, they are forced up again as soon as their numbers on the lower areas become at all conspicuous.

The feeling between the "cattleman" and "sheepman" is here, as in the majority of the open range regions, often a very bitter one. The "sheepman" having a herder to look after the interests of the flock has a decided advantage over the "cattleman," whose interests

FIG. 1.—A DEPLETED RANGE IN STEINS MOUNTAINS, OREGON.
Objects in foreground are dead stools of sheep fescue.

FIG. 2.—SURFACE VIEW OF SOIL IN PINE FOREST MOUNTAINS, NEVADA, AFTER CLOSE GRAZING BY SHEEP.

have but little care during the summer. The sheep herder claiming as good a right to the free grass of the range as anyone, naturally drives his flocks where the best feed is found; and, on account of the necessity of securing green fodder for the lambs, he travels up the mountains in the spring as fast as the feed and weather conditions permit and returns to the desert areas again during the winter, often close to the possessions of the "cattleman." The latter claims that on account of his owning property and paying taxes for the support of the local government, which the sheep owner often does not, he has a right to the free range in his vicinity.

The greatest difficulty and hardest feelings relate to the migratory sheep bands which come, not only from neighboring counties, but occasionally from neighboring States, and deprive the settlers of the good mountain pastures which they consider belong to them on account of their residence, their holdings, and their support of township and county governments. The sheep industry, in the southern portion of the region especially, is in a peculiar condition. All of the water on the fertile lowlands was taken up in early days by cattle interests, and the cattlemen looked upon the use of the mountains for grazing purposes as a natural right. In recent years sheep have been driven from great distances both east and west into the mountains to take advantage of the luxuriant pastures of blue grasses and fescues. Another element entering largely into the controversy is what is denominated the alien sheep interests. It is said that a very large proportion of the sheep in the region belong to Basques, who own no land, and who in many cases are not citizens.

THE RANGE.

It would be very difficult indeed to find a range in which the pasture zones as well as the general floral areas were better marked than they are in the southern portion of the territory covered. The vast barren tracts in the basins are bordered by the alkali-inhabiting vegetation, such as salt grass, greasewood, and others of similar habits. These give place beyond to shrubby plants, such as the black sage and the salt sages, described elsewhere. The former occupy the lower portions of the general mesa regions and extend into the foothills and mountains. The prevailing characteristic of the foothills and mountain regions, however, is the presence of the nutritious grasses which furnish the summer feed for the numerous herds of cattle and sheep. While the species of grasses in this region are numerous, there are about four which furnish the largest quantity of feed. The most important of these is Buckley's blue grass (*Poa buckleyiana*), which grows at the lowest altitude in the foothills and extends into the mountains. On the steeper embankments, rocky slopes, and canyon sides are usually found large quantities of Wheeler's blue grass (*Poa*

wheeleri) and bunch wheat grass (*Agropyron spicatum*). Beyond the blue-grass zone of the foothills and lower mountain areas occur the finest pasture lands of the region. These, while in all probability furnishing no more nutritious grass than the foothills, are much more attractive and in some respects much more important than the former, owing to the fact that they are more often free from shrubbery and other plants with little or no forage value, and consequently furnish a larger quantity of feed per acre. This is the sheep fescue area, and this important grass in one of its two principal varieties grows often to the exclusion of all other forms of vegetation.

The first of these zones, that including and immediately surrounding the barren basin bottoms, is greatly modified in certain localities. Wherever there is a small valley contributing water to the basin or river bottom, the general alkalinity of the region has been neutralized by the beneficial action of the rich sediment brought down from the mountains, or otherwise counteracted to such an extent that the soil has been made very rich and productive. By these methods delta-like areas have been built up in the lower valleys or ravines or in borders of greater or less width along the river courses. It is in these areas that the ranches of the region are built, and it is upon them that the region is dependent for its winter feed, consisting sometimes of excellent but often very ordinary crops of native hay and forage plants. On the more elevated portions of the lower valleys where the drainage is good and where, under natural conditions, the black sage (*Artemisia tridentata*) predominates, is located the best soil, as experience has demonstrated, for the culture of alfalfa, the main cultivated hay crop, and, indeed, about the only crop of any kind upon which much dependence is placed.

One may therefore recognize three typical forage zones or areas, namely: Lowlands, including river bottoms, and low areas in basin-shaped depressions furnishing winter feed in the shape of pasture and hay, but more especially the latter at the present time; the mesa, including the intermediate zone between the lowlands and the next named, furnishing but little feed except browse, its main resources consisting of shrubby plants, such as true sages, salt sages, white sage, and red sage; and the highlands, including the foothills and mountain region, which furnishes practically the entire summer pasture. The general appearance of some of the lowland areas, with their characteristic vegetation, are shown in Pls. II, fig. 2; XIII, fig. 2; XIV, fig. 2, and XV, figs. 1 and 2. The surface soil on the mesa region is for the most part uncovered, the shrubby vegetation usually being much scattered and only from 2 to 3 feet high. Some idea of this region can be gained from Pls. I, fig. 2, and III, figs. 1 and 2. It may be a broad, gentle, sloping plain, as shown in the first figure, or exceedingly broken and fissured by deep ravines. The highland, including, as stated above, both foothills and mountains, while producing a much larger amount

of feed than the mesa, has by no means its entire surface covered with vegetation. The shrubbery has been spoken of elsewhere. The black sage (*Artemisia tridentata* and *A. arbuscula*) growing in scattered bunches, have here, unlike the mesa region, a considerable growth of scattering bunches of grass between them. The grasses are nearly all of the perennial varieties, and consist mainly of blue grasses, sheep fescue, and wheat grass, all of which grow in bunches and form but little, if any, turf. Pls. I, fig. 1; II, fig. 1; IV, fig. 1; V, figs. 1 and 2; VI, fig. 1, and XIII, fig. 1, give fairly typical representations of the grazing areas on the uplands.

A careful study of the forage plants of one of the basins of this region, with an equally exhaustive soil study covering a period of nine or ten months and extending from the bottom of the basin to the top of the mountains, would prove not only of great scientific interest, but would undoubtedly throw very important light upon many features of the forage problems as they exist throughout this general region. As a suitable locality we might mention the Alvord Desert basin, where the distance from the desert lake bed in the bottom of the basin to the line of perpetual snow in Steins Mountains is not too great to be covered on foot in a single day, while extensive deposits of borax are located in the same depression about 20 miles away. A thorough correlation of soil conditions with the development of forage plants could be easily made here and would doubtless apply to large areas of country. A study of the conditions best suited to the development of the characteristic forage plants could easily be made, and the rôle of the shrubby vegetation in the economy of stock raising could be accurately determined, a point upon which there is altogether too little accurate information at the present time. A comparative study of the native clovers upon newly irrigated sagebrush soil and their native habitats in the lower, boggy, and almost peaty areas, and the rapidity of their spread into newly irrigated areas contiguous to their natural habitats, would be very instructive. A comprehensive study of the condition under which these valuable forage plants develop to the best advantage would be of great economic importance. Whether they develop best when growing alone or in combination with more rigid plants, which assist in their support, and the quantity of feed which they produce could be determined here by observation of their habits under natural conditions. No better locality could be selected for the study of the specific distinction of two of the valuable groups of range grasses, namely, the sheep fescues and that group of blue grasses closely related to Buckley's blue grass. A question of much economic interest to this region, as well as to all that grazing area to the south and southeast, relates to the value of the early weedy plants as cattle food. A knowledge of these is necessary—what they are and to what extent they are eaten by cattle and sheep. But little investigation has been made of the desert ranges in spring and early

summer, when they yield much feed consisting of short-lived annual plants differing very materially both in kind and quality from the grasses which grow at this season in regions of more copious and equable rainfall. It is well known that Indian wheat (*Plantago fastigata*), Nuttall's vetch (*Astragalus nuttallii*), and similar weedy plants play a very important part in the economy of stock raising in the deserts of the Southwest. Here also we have a desert range which produces a large and comparatively abundant crop in early spring, forming at least much sheep pasture, concerning which but little is known aside from the information derived from an occasional statement and description by observing ranchers. These are some of the economic questions that might be studied on local representative areas like this one. The purely scientific questions, whose bearing upon practical ones seldom can be properly appreciated, are altogether too numerous to be considered.

RANGE CONDITIONS.

The condition of the lowland pastures and meadows has been briefly spoken of elsewhere. These areas are at the present time almost invariably the property of private individuals, and consequently under their direct control and management. The bottom lands which still remain open to settlement are so situated that no water is available for their irrigation, the control of water in the streams being in the hands of the owners of the first ranches settled. Inasmuch as the supply is scarcely sufficient for the use of these first comers, there is no inducement to the prospective settler to take up the other open-range bottom land, although it may be equally as productive. If convenient to water holes, these areas are always closely grazed and present a very unpromising appearance. No open-range lowland was seen on the whole trip which had much feed upon it excepting that consisting of the tough and persistent salt grass. Everything else had been cropped closely. In many localities cattle were apparently subsisting on this grass.

The more favored and protected areas under private control, although altogether too closely pastured, fare much better than the open range. As stated before, these furnish the native hay of the region during the summer and the pasturage of the strong cattle during the winter. The principal feed is found, not on the areas actually cut, but among the willows, along ditches, and in low swampy areas which remain uncut. These, although usually small, amount to many acres in the aggregate on seven or eight square miles of meadow. The shrubbery and tule (*Scirpus lacustris*) also furnish shelter during severe weather. It is needless to say that these areas are taxed to their full capacity. A piece of ground from which a crop of hay is removed during the summer will not usually maintain its productiveness in any region if every particle of vegetation remaining is pastured off during the fall and winter seasons. It is only under conditions of the most favorable

FIG. 1.—SHOWING HABITS OF SHEEP DURING THE COOL MORNING, STEINS MOUNTAINS, OREGON.

FIG. 2.—SHOWING HABITS OF SHEEP DURING THE HEAT OF THE DAY, PINE FOREST MOUNTAINS, NEVADA.

supply of moisture that the continued yield can be maintained. No more convincing evidence of the deterioration of these meadows in recent years was found on the whole trip than that furnished on the Alder Creek ranch, at the base of Pine Forest Mountains. Here the native hay meadow consists of an elongated, comparatively narrow basin extending toward the desert from the mouth of a canyon leading into the mountains. The remains of old stackyards were found for 5 or 6 miles down this meadow from the ranch. They were scattered at short intervals. At one time these were built to surround stacks of hay cut on these meadows, but they were all unused this year, except those nearest the source of water supply from the canyon.

The shortage of the native hay crop here is influenced largely by the fact that the water has been used up in late years in the irrigation of alfalfa, as well as by overstocking. This is an important factor in the modification of the conditions on all of the native hay lands. The water has been turned from its natural course, and, instead of irrigating the meadows as it once did, it is used to a large extent in the irrigation of the land which is situated just above and which naturally produces nothing but black sage (*Artemisia tridentata*). The packing of the soil by the trampling of large numbers of cattle during the fall and winter also has a very marked influence on the hay crop. The soils are as a rule unusually hard and stiff, and this condition is aggravated by the constant trampling of the cattle. One practice decidedly beneficial is the feeding of the hay on the ground which produces it. This results in returning the manure to the land and compensates in a measure for the crop taken off. The fact that the meadows have poor drainage serves to keep the refuse upon the land where it will soak into the soil during the spring-flood season.

The injury to the mesa from overstocking is largely local. The shrubbery is usually not relished as much, and consequently is not grazed as closely as the grasses. The most conspicuous desert shrub is the black sage brush, which is not eaten except in extreme cases, even by sheep. The spiny saltbush (*Atriplex confertifolia*) and hop sage (*Grayia spinosa*) usually bear evidence of browsing, but not to any injurious extent. The greasewood which in localities is even more conspicuous than the black sage is, as far as observed, never injuriously grazed, the main use that stock make of it being that of licking up the fallen leaves. This is true to some degree of the spiny saltbush and the hop sage, but these are also browsed. The shrubby mesa plants which have suffered most from overstocking are three in number. The red sage (*Kochia americana*) appears to be always closely cropped during the winter, although not eaten to any extent during the summer. Bud sage (*Artemisia spinescens*) almost invariably bears evidence of cropping, but it is probably eaten much more extensively by sheep than by cattle. The value of white sage as food for both cattle and sheep is well known and, as would be expected in a

region of such short pasturage, it is very much injured by overgrazing. According to the best information we were able to get, this plant furnished a very large amount of feed on the mesa region at one time, especially to the south of the Alvord Desert. The only place where we found it in sufficient quantity to be of any great value was in the vicinity of the upper end of the Black Rock Desert, between Leonard and Bartlett creeks. It is common enough in the vicinity of Quinn River Crossing, but either on account of close grazing or drought it made but little growth this year. As seen on this trip the plants consist of only a stump and a few shoots 6 to 10 inches long. Last year's growth was invariably completely grazed off.

Inasmuch as the best grazing areas are on the highlands, the principal interest pertains to these. Representative areas of six ranges of mountains were carefully studied at the important transitional stage in the history of all ranges, when the grasses were ripening. This process occurred much earlier than usual this year according to the most reliable information obtainable. Special trips were taken into the Pine Forest, Bartlett Peak, White Horse, and Steins mountains, and a spur of the Blue and Bendire were crossed on the regular stage route.

With the curtailing of the range and consequent driving of the open-range business into the more inaccessible and rocky areas, overstocking must inevitably follow. This condition has been reached in practically all the open ranges of the country, but more interest is attached to this condition in those regions where the grasses do not form a sod, as is the case with the one in question, because trampling and close grazing result in more speedy and permanent injury than in the sodded regions. To say that the southern portion of the region is overstocked would be putting the matter very mildly. The more northern portion over which we traveled was in better shape. The Bendire Mountain region especially had exceptionally good feed, and was, as a whole, the best range which we saw on the whole trip. Portions of the Blue Mountains were also in very good condition. In all the other highlands overstocking was very conspicuous. The White Horse Mountains were being pastured by sheep the second time this season. They were grazed earlier in the summer, and flocks were being driven into them again from the Disaster Peak country when we were there early in August. One herder reported that the latter place was all eaten out and that he moved his flock in order to avoid trouble with other herders who were quarreling and disputing over the little grass left. The first pasturing had left the range short enough; what the second will do can be easily imagined.

The most closely pastured region visited was Steins Mountains. On the whole trip of three days we found no good feed, except in very steep ravines, until we reached the vicinity of Teger Gorge. On a portion of the trip from here to Manns Lake there was a good stand

FIG. 1.—CATTLE RANGE IN PINE FOREST MOUNTAINS, NEVADA.

FIG. 2.—HERDER'S HABITATION DURING THE SUMMER GRAZING SEASON IN STEINS MOUNTAINS, OREGON.

of grass, the side of the gorge and the area immediately to the east being exceptionally fine. There were a good many cattle in the locality, but no sheep had been pastured there this season. In places from Ankle Camp to Nuttersville, a sheep supply camp, there was practically no more feed than on the floor of a corral. We passed two areas at least 2 miles in extent in which even the surface of the ground was reduced to an impalpable powder. Pl. IV, fig. 2, taken in the Pine Forest Mountains, shows the condition of the surface of the ground after close pasturing by sheep. This evil effect is most likely to occur in the sagebrush and other shrubby areas, mainly on account of the habits of the sheep. Pl. V, figs. 1 and 2, illustrates the point in question. During the morning the animals feed, spreading out over more territory and move about, while during the heat of the day they get as much shelter as possible, hanging their heads in the shade of the shrubbery, if such is available. If not, they bunch up together and use the shade furnished by the bodies of the other animals. They feed and move around but little; on the contrary, remain in nearly the same place, although they keep their feet in almost constant motion. This movement of their feet on the surface of the ground for hours at a time reduces it to a fine powder. The illustration, Pl. IV, fig. 2, is from a photograph taken with the camera pointing downward, and covers a space of about 28 by 40 inches. An analysis of this figure, which is typical of the effect of close sheep grazing in all of the shrubby areas, will show two species of plants upon the soil—one is a lupine on the extreme left, the other is sheep fescue (*Festuca ovina*), two bunches of which are shown, one on the extreme right and the other a little to the left of the upper central portion of the figure. The leaves of the lupine, a plant seldom eaten, are seen scattered over the surface of the ground. The other objects shown are sticks and pebbles.

The injury to the open grassy areas from overstocking results mainly from too close cropping, which exposes the bunches of roots to the direct rays of the sun, and deprives them of the beneficial action of the accumulation of débris from previous years, both in protection from excessive heat and in holding moisture. On this trip we crossed three areas of this grass, varying in extent from 3 to 60 acres, upon which the beautiful pure growths of sheep fescue were completely ruined. The bunches of great size were completely killed. Pl. IV, fig. 1, shows one of these localities. The objects in the foreground are mainly closely cropped bunches of this beautiful grass which under natural conditions stands at a height of from 1½ to 2 feet, and, although in bunches 4 to 10 inches apart, the abundant and graceful culms cover the entire surface. Under ruinous pasturing the bunches appear to die usually from the center. One may often find in these mountains a narrow green ring fringing a dead center. It is a very striking

characteristic, and is found in many places. In the figure referred to above the grass is completely killed.

Sheep fescue produces an abundance of seed and is easily grown in the cooler regions of the United States, but whether it will reseed itself readily on the open range when thoroughly killed out over a certain area does not appear clear. As far as we know there are no definite observations on this point, but judging from the habits of the grass, the general appearance of the bunches, and observation of the denuded areas visited, the process will be exceedingly slow. One small ruined area visited had the appearance of having been used as a bedding-down place about two years ago, and evidently had not been pastured since. Here the old bunches of roots needed nothing more than a kick to remove them from the ground. There appeared to be no evidence that the area was being reseeded, nor that other permanent vegetation was taking the place of this one. It appears from these observations that the process of recuperation when once the grass is killed will be exceedingly slow.

Some statistics obtained from Mr. J. M. McKissik, who runs a camp in the mountains to supply the needs of the herders, show the enormous drain that is made upon these mountains for summer pasture. According to his statement a rough census was taken at the camp a few days previous to our arrival, in which it was ascertained that there were 73 flocks of sheep on the top of Steins Mountains at that time, each flock averaging about 2,500 animals. Conservative estimates of the area in which this pasturing was being done, furnished by the range riders and ranchers familiar with the region, give the length of the area as 50 miles by an average width of 8 miles, or 400 square miles. Accepting the rather low average of 2,500 animals to the flock, the figures indicate that there are 182,500 sheep, or over 450 animals to the square mile. According to Mr. McKissik's estimate of the area, there were over 1,000 sheep to the square mile. It is believed that the other estimate is more nearly accurate. The season of pasturage extends over fully four months, and at times from four and a half to five, depending upon the advent of the autumnal storms. Nor is this all. It must be remembered that there are cattle ranches located around the base of the mountains. Among these are ranches belonging to the French-Glenn estate and the Pacific Live Stock Company. These and about a half dozen smaller ranchers run their cattle into the same region as much as possible during the summer season. With these figures before us it is needless to say that feed was short, and that already in August some flocks were being driven onto what is known as winter pasture on the lower levels, which are not usually pastured until the middle of October.

The shrubbery plays a very important part in the forage supply of the mountains also. The extensive areas of cinquefoil (*Dasiphora fruticosa*) and Indian currant (*Symphoricorpos oreophilus*) are invariably

defoliated by the sheep. It was difficult to find a twig of the former large enough to make a good herbarium specimen. Really the only shrubs not eaten here appear to be mahogany (*Cercocarpus ledifolius*) and snowbush (*Ceanothus velutinus*). Willows are always trimmed up as far as the sheep can reach, and the poplar (*Populus tremuloides*) is not only browsed, but the young trees are often completely girdled. There are two other plants which might be classed with those not eaten by sheep, namely, the sages (*Artemisia tridentata*) and *A. arbuscula*, to which should be added the long-leaved sage (*A. cana*), which is abundant in some localities in Steins Mountains. Even the wild chokecherry (*Prunus emarginatus*) is often browsed. The poplar thickets are trimmed up, however, by both cattle and sheep. While the sheep actually eat leaves, twigs, and bark of the young trees, the cattle tramp through the groves a great deal, especially in fly time.

Being familiar with the destruction of the surface of the country in the deserts of southern Arizona as a result of the removal of the vegetation and the packing of the surface by the trampling of large herds of cattle, a constant effort was made to ascertain the effect of the same agencies here. The conditions in this region, however, with reference to soil characteristics, character and amount of precipitation, and configuration of the surface are very different from those of southern Arizona; and the effect of flood waters are consequently by no means identical in the two localities. A comparison of the rainfall of the two regions will show that the precipitation at Winnemucca, Nev., is less by about 4 inches per annum than at Tucson, Ariz. This, coupled with the fact that the summer showers are much less frequent as well as less violent in the former than the latter place, would lead one naturally to infer that the waters would be much less destructive. The real mollifying influence, however, is not to be found in either the character or the quantity of the precipitation, but in the soil of the mesa, where the destructive action is the most pronounced. It is the impervious soil that always washes badly. The surface of the mesa in northern Nevada and southeastern Oregon, as far as observed, never bakes nor otherwise becomes hard and impervious to water, as do those lying over the caliche hardpans of southern Arizona. Here the hard impervious soils are found on the bottoms in the basin-like depressions and sinks and along poorly drained river banks. It will be readily seen that the effect of erosion would be to build up and level rather than to cut gorges. It is not meant that there are not notable incidents of recent erosive action here, but an attempt is made to show that the conditions are not as favorable for it and that it is insignificant compared with the same phenomenon on the southern deserts.

Fire has a direct influence upon the condition of the feed. Burning is as destructive to the grass of the range as to the trees of the forest. Indeed, it had sometimes been thought in more extended observations

on the prairies of the Dakotas that fire is really more injurious than close grazing. This region is too far removed from railroads to have the numerous conflagrations attributed to that source. It can be attributed to no other agency than that of criminal negligence. In traveling from Burns to Drewsey, via Silvies, we passed over areas where six separate fires had raged during the past two or three months. Two or three of these were in progress when we passed through. In every mountain range visited evidences of fire were found. Even the snowbush (*Ceanothus velutinus*) was burned off in places in the vicinity of Bartlett Peak and in the White Horse Mountains. There appeared to be good evidence that the one in the former area was willfully set for the purpose of facilitating the movements of bands of sheep from one pasture to another. This evidence was corroborated by at least six individuals. The site of an old fire in the White Horse Mountains, set by Indians about three years ago, was very interesting from both scientific and economic points of view. The shrubbery was of course all burned off and a little of it was growing again from the stumps. The grasses showed a very marked difference in the degree to which they succumbed to the effects of the fire. The fescues appeared to be all killed, while the Nevada blue grass was growing nicely. Buckley's blue grass withstood the fire better than the fescues, but not nearly so well as the other blue grass.

It is strange that more care should not be taken of the little shrubbery and timber that exists in the region. It is with the greatest difficulty that the ranchers from Winnemucca to Burns are able to get sufficient wood for posts and fires. On many ranches poplar and juniper is about the only available timber for fence posts, and these must be hauled from 30 to 50 miles. Where brush and wood are so scarce and mean so much when considered from either standpoint of immediate use or that of conservation of moisture and protection of soil, more care should certainly be exercised to prevent fires. As an example of negligence we might mention one which came under our direct observation while en route between Silvies and the Calamity settlement. On reaching the headwaters of the Calamity drainage we met two parties, one evidently campers, the other a round-up outfit. Farther down the valley we discovered a locality where some party had camped the previous night. They had built two fires, one of which was kindled at the base of a large pine, which, at the time we passed it at 9 o'clock in the morning, was burning vigorously up to a distance of 10 feet above the ground. It is true that the whole region had been burned off a short time before. There was consequently no danger of further destruction excepting to this one tree, but the same negligence would doubtless obtain under other circumstances. It is needless to say that the winter feed was completely destroyed, and that it will take both grass and timber many years to recover

FIG. 1.—SHOWING THE HABITAT AND A FAIR CROP OF PRAIRIE BULRUSH ON MANNS LAKE RANCH, 20 MILES NORTHEAST OF ANDREWS, OREGON.

FIG. 2.—TETRADYMIA AND PSORALEA HOLDING DRIFTING SANDS, 20 MILES NORTH OF WINNEMUCCA, NEVADA.

from the effects of this one fire. It appears that much less vigilance is exercised in the control of fires in this region than in the pasture and forest lands of Montana and Wyoming, due, no doubt, to there being on the whole less combustible material, and consequently less probability of fire spreading, as well as to the fact that the country is more sparsely settled, and, therefore, the interests at stake are less carefully guarded.

HAY CROPS.

A general description of the lowland hay meadows has already been given. It remains simply to give a brief account of the principal hay crops, their quality and something relative to the methods of handling. Nothing is more evident than the fact that the yield is in direct proportion to the amount of care and the amount and distribution of water which the native meadows receive. The quantity of hay raised on the different ranches is enormous. Its quality, however, is rather low, for there is mixed with it oftentimes large quantities of wire grass (*Juncus balticus*), squirrel tail (*Hordeum jubatum*), tule (*Scirpus lacustris*), various species of sedges (*Carex* sp.), creeping spike rush (*Eleochris palustris*), and other plants having a smaller feeding value than the majority of the true grasses and clovers. Many sedges, however, produce hay of very fair quality.

The methods of irrigation of the native meadows are very primitive indeed. The waters during the flood season are held on the land as much as possible by the aid of low rough dams constructed of earth, brush, or refuse material. This plan floods the hay areas for periods varying from one to three or four weeks. After these spring floods pass by there is practically no more water for the native hay meadows until the advent of cold weather, when the lower areas again become flooded, and remain so, in some cases, until early summer. It will be readily recognized that this condition is not conducive to the development of the grasses, but furnishes, on the contrary, the exact environment suited to the growth of the poorer qualities of forage plants mentioned above.

In spite, however, of the natural disadvantages of poor drainage and heavy stocking, large and magnificent crops of hay are raised on some areas on all the ranches. The best hay, when both quality and quantity are considered, is probably furnished by the wild wheat or blue stem (*Elymus triticoides*), which furnishes oftentimes as high as 2½ tons to the acre. Especially fine meadows of this were seen on the Humboldt River bottoms at Winnemucca and in the Quinn River Valley at Quinn River Crossing. (See Pl. XIV, fig. 2.) The best quality of native hay is doubtless furnished by the bunch blue grass (*Poa lævigata*), which in favorable years and localities makes an

excellent stand and furnishes from 1½ to 2 tons of hay per acre. Next in importance to these two grasses should be mentioned the native clovers, several species of which are to be found in the region, but the most important one is *Trifolium involucratum* in some of its various forms. Both the quality and quantity of the hay furnished by these plants are excellent. They grow very profusely in the low boggy sedgy meadows, and very naturally improve the quality of the native hay in these situations, which, were it not for these leguminous crops, would produce little aside from the sedges and rushes. Very often, as was the case on the Divine Ranch, these furnish one-half of the hay on these areas, the remainder being furnished by the sedges and rushes. Occasionally giant rye grass (*Elymus condensatus*) is cut for hay on the drier bottoms. It makes a coarse quality of forage, and its main use is winter pasturage. (See Pl. XIII, fig. 2.) The following list of forage plants from the meadows of Quinn River Crossing are representative and give a good idea of the character of the vegetation on these areas: Sedges (*Carex lanuginosa*, *C. douglasii*, and *C. nebraskensis*); salt grass (*Distichlis spicata*), red top (*Agrostis alba*), alkali saccaton (*Sporobolus airoides*), squirrel tail (*Hordeum jubatum*), wild barley (*Hordeum nodosum*), orchard barley (*Sitanion longifolium*), wild wheat (*Elymus triticoides*), giant rye grass (*Elymus condensatus*), slender wheat grass (*Agropyron tenerum*), bunch blue grass (*Poa lævigata*), steel grass (*Sporobolus depauperatus*), slough grass (*Beckmannia erucæformis*), beard grass (*Polypogon monspeliensis*), creeping spike-rush (*Eleocharis palustris*), rush (*Juncus balticus*), prairie bulrush (*Scirpus campestris*), tule (*Scirpus lacustris*), clover (*Trifolium involucratum*), seaside arrow grass (*Triglochin maritima*), cat-tail (*Typha latifolia*).

The native meadows of the Malheur Lake bottoms deserve special mention. The principal study of these was made on the Island Ranch between the forks of Silvies River. The quantity of water with which these areas are flooded is enormous and remains upon the ground for a long period. Consequently, the sedges and rushes develop to an astonishing extent. There are here grasses also which make an excellent growth. (See Pl. XV, figs. 1 and 2.) The one characteristic above all others which impresses one is the exceedingly patchy character of the vegetation on the low, level, poorly drained bottoms. The most valuable forage plants appear to be the wild wheat or blue stem (*Elymus triticoides*), prairie bulrush (*Scirpus campestris*), sprangle top (*Scolochloa festucacea*), awned sedge (*Carex aristata*), and yellow top (*Calamagrostis hyperbora americana*). These forage plants, together with the less valuable tule (*Scirpus lacustris*), rush (*Juncus balticus*), cat-tail (*Typha latifolia*), creeping club rush (*Eleocharis paulstris*), and bur-reed (*Sparganum eurycarpum*), are scattered around over the bottoms in areas of variable extent, but usually in patches of but few

FIG. 1.—STACKING HAY WITH A JACKSON FORK AND TRIPOD, THOMPSON BROTHERS' RANCH, NEAR BEULAH, OREGON.

FIG. 2.—STACKING HAY WITH A "SLIDE," ISLAND RANCH, MALHEUR LAKE BOTTOMS, OREGON.

A ton of hay is on the slide.

rods in diameter, or, as is usually the case with the yellow top, in narrow fringes along the lower areas. Large quantities of hay consisting of almost pure sprangle top and prairie bulrush were being harvested on the ranch when we were there.

The cultivated forage plants are few in number. As in all the arid West where irrigation is practiced, alfalfa is found to be by far the most profitable crop, and it seems especially well adapted to the only tillable soils of the region, namely, the lower sagebrush areas. Whenever water is available for irrigation the sagebrush lands invariably raise good crops of this important forage plant. It is in the northern portion of the region covered that it is raised most extensively and profitably. One field near Ontario, Oreg., was pointed out to us as having raised last year 10 tons per acre in three cuttings. It was an unusually fine field, and care had been taken to get a good even stand. (See Pl. XIV, fig. 1.) Judging from the comparative appearance of other fields in the vicinity, 6 tons per acre would be a fair average for the region. Farther south, where water is less abundant and only two cuttings are made, 3 or 4 tons would be a good average. Here considerable growth occurs in the fall after the second cutting is made, but this is usually pastured off by cattle which are turned into the fields during the winter. In this way the alfalfa fields, as well as the native hay meadows, furnish both hay and winter pasture.

Redtop (*Agrostis alba*) is widely introduced in the basins of Nevada and Oregon and often furnishes large quantities of hay and pasture on the low, moist bottoms. It is of more importance from the Alvord Desert region north than it is farther south. The first place where we saw a good stand of it was on the Divine ranch.

Timothy is being more widely introduced in recent years and is said to withstand the alkalinity of the soil better than any other forage plant known to the ranchers of the region. Instances were cited to us of successful stands having been obtained on soil which produced nothing but greasewood. In some places on the Divine ranch there were fine crops of it. In one field the hay consisted of about equal quantities of timothy, redtop, and native clover, a most excellent combination for a good quality of hay. Mr. Divine reported that the clover had "come in" of its own accord, and that the redtop in this particular field was the result of having fed redtop hay which was hauled in from a small ranch established in early days farther down the valley.

METHODS OF HANDLING HAY.

The methods of handling hay crops are certainly unique and in thorough keeping with the extensiveness of all the operations connected with stock raising in the region. The many appliances used permit of handling the crop to the best advantage and with the least

possible expense. On the majority of the ranches practically all of the work is done by machinery. There are some, however, who purposely sacrifice speed and manual effort in the handling of alfalfa, especially, to enable them to gather the crop with less loss than by the use of machinery, but more will be said regarding this feature later.

In harvesting a crop of hay a crew of from sixteen to thirty men is employed to attend to the various operations of mowing, stacking, bucking, net tending, hoisting, sickle grinding, and blacksmithing during the entire haying season, which lasts from two to three months. Pls. VIII, figs. 1 and 2, IX, figs. 1 and 2, and X, fig. 2, show some of the machinery used in stacking or piling up the hay, as the process is often very appropriately called, in actual operation on the ranches in eastern Oregon. Probably the most rapid method of any in vogue is that known as the "slide" method, which is employed only on the largest ranches where native hay is the predominating crop. A "slide" consists essentially of a huge, strongly built inclined plane. The hay is brought up to the base of the plane, usually by a four-horse buck, and deposited in a net, to which is fastened a cable stretched over the top of the plane and the entire stack. The other end of the cable is attached to the fore truck of a wagon, to which is hitched a four-horse team. When the load has been drawn up and discharged in the proper place on the stack, the net is drawn back to the base of the plane again by a single horse, readjusted, and reloaded. The four-horse buckload will average about one ton of hay, and a load will be run onto the stack once in six to eight minutes when the machinery is in good working order. Pl. VIII, fig. 1, shows the process of stacking by the use of this machine in actual operation on the Island Ranch, near Burns, Oreg. Another method more extensively employed than the "slide" is represented in Pl. IX, fig. 1. This is very similar to the former, differing from it only in the substitution of a derrick for the slide. The bucks and net are used in both cases, but their capacity is usually smaller than those operated by four horses instead of two. Where the ground is very rough a drag buck is substituted for the wheeled one in ordinary use. Pl. X, fig. 2, illustrates one of the large four-horse bucks—the smaller ones differ but little except in size.

Both of these processes are best adapted to the handling of native hay, which is not much injured by rough treatment. The bucks are especially hard on alfalfa, one of the most difficult hay crops to cure and handle properly. With rough treatment, such as it is certain to receive when bucked to the stack, the friable leaves, the most valuable part of the plant, are almost certain to be largely broken off. To obviate this very decided objection many of the ranchers discard the bucks entirely in handling the alfalfa crop and haul the hay to the stack in wagons. It is then unloaded by means of a derrick or tripod arrangement and a Jackson fork, as shown in Pls. VIII, fig. 1, and IX, fig. 2.

FIG. 1.—STACKING ALFALFA WITH A DERRICK, HARPER RANCH, NEAR WESTFALL, OREGON.

FIG. 2.—STACKING ALFALFA WITH JACKSON FORK, ARCADIA RANCH, NEAR ONTARIO, OREGON.

Stacks are 375 feet long, 75 feet over, and 28 feet across.

In this way the leaves are saved and the most difficult part of the manual labor, the transfer of the hay from the load to the stack, is still accomplished by the use of machinery. Another very decided disadvantage of the "slide" method results from the difficulty of making the stacks waterproof. Of course this can be accomplished, but when a ton of hay is dropped in one place on the stack and similar quantities are put up at such short intervals, the stackers do not usually work it over so as to make the mass of uniform density. The consequence is that there are places in the stack that are not well packed. When the hay settles "holes" occur, allowing the rain water to drain into the stack. This would not be of so much importance if all of the crop were fed the year it is cut, but this is often not the case. Much hay is sometimes held over to be fed the subsequent year. It is needless to say that if not properly stacked it deteriorates very much in value. Some of the last year's stacks of native hay put up by this method which we examined were at least one-half rotten or moldy, while alfalfa stacks carefully put up by the derrick method had deteriorated but little, although native hay can be made to shed water much easier than alfalfa.

All of the hay raised is for home consumption and, in practically all cases, is fed in the same fields where harvested. This is due not only to the good price of beef, mutton, and wool, but also to the prohibitive transportation tariffs and long distances from market.

SAND BINDERS.

All plants growing on sandy lands which are shifted by winds act as sand binders and prevent, to a greater or less extent, the movement of the sands. If a plant grows on such areas, therefore, it is to some degree a soil or sand binder, and whether valuable as forage or not, it serves a useful purpose in preserving the surface of the land intact until it shall have become stable enough to support other and less persistent vegetation. The appellation, sand binder, is therefore one of degree rather than of kind, although usually applied to those plants which have a means of efficient propagation enabling them to develop rapidly and furnish a protective soil cover in regions where the configuration of the surface is easily disturbed. The two first named plants may be classed as true sand binders. The others perform some service in this respect, but they have no special means of propagation which enables them to draw upon the moisture and fertility of the deep-lying strata and at the same time extend the area over which they grow rapidly during dry weather.

Psoralea (*Psoralea purshii*).—This plant, although it does not grow on soils which change their positions as rapidly as the next, is still, on account of its abundance in very sandy soil and under very adverse conditions, the most important soil binder of the region. Many large areas are to be found in northern Nevada, especially in the vicinity of Winnemucca and on the narrow strips of sandy land which are usu-

ally found in the vicinity of the basin-shaped depressions described elsewhere, which have very little vegetation aside from this plant.

DELEA (*Delea kingii*).—On the sand hills about 20 miles north of Winnemucca, this is the only plant which is able to sustain itself in rapidly shifting sands. It usually grows sparingly but evenly over large areas, propagating rapidly by its long slender reddish rootstocks, which may be easily pulled up out of the loose sand through which they ramify. The spinescent branches, the yellowish-green coloration of the leaves, the reddish rootstocks, and the purple flowers give this plant a very characteristic and striking appearance as it spreads over freshly formed hillocks and mounds of sand.

TETRADYMIA (*Tetradymia comosa*).—Large bushes of this were found in abundance in the same vicinity as *Dalea kingii*. Almost invariably they were situated upon mounds or half buried in the sand, indicating that the soil had been removed from the surrounding areas or had been piled on top of the plants. Pl. VII, fig. 2, illustrates the effectiveness of this plant in preventing the sands from drifting.

MOSS (*Tortula ruralis?*).[a]—It is with considerable hesitancy that a moss is recorded as a sand binder, but that this species serves this useful purpose over quite extensive areas in northern Nevada and eastern Oregon is perfectly apparent to anyone visiting the region between June and October. This small plant does not grow over the entire mesa, but, on the contrary, is confined to circumscribed areas immediately beneath and immediately surrounding shrubby plants, such as black sage, spiny saltbush, tetradymia, and the shad scale. Its period of growth is evidently late winter and early spring, at which time it forms a complete covering for the ground. When conditions of drought appear it dries up completely, and, while easily removed from its position, it forms mats which catch the sand that blows into it, and serves in this way to enlarge the small mounds which appear surrounding the desert shrubbery. Every area of this plant examined was almost completely imbedded in sand. That it grows in this way is not at all likely, because an abundance of leaves were always found below the surface of the sand, indicating that the plant had been covered after the advent of dry weather in late spring and early summer.

Besides the plants mentioned above, many others might be named in this connection. The sandy area on the south and east of the Alvord Desert in southern Oregon showed a very marked influence of some of the common desert shrubs upon shifting sands. Among plants which acted as sand binders in this locality and were almost invariably found in hillocks of sand may be mentioned the spiny saltbush, shad scale, and the black sage.

WEEDS.

It will be noticed that this short account gives special prominence to native plants which occur to such an extent as to be classed weeds. This is not at all to be wondered at in a region so little improved as the one in question, and, in a region where the preponderance of the crops on both pasture and hay lands are harvested on the untilled ground, and consist of native plants which receive no other care than that of harvesting. Under conditions where the pasture and hay lands are taxed to their full capacity, the fact that some plants which are not relished by cattle increase to an unsightly or even alarming

[a] Determined by Mrs. E. G. Britton.

FIG. 1.—A HAY CAMP, ISLAND RANCH, MALHEUR LAKE BOTTOMS, OREGON.

FIG. 2.—LOADED FOUR-HORSE BUCK, MALHEUR LAKE BOTTOMS, OREGON.

extent is not at all surprising. No attempt is made to give a complete weed list for the region, but, on the contrary, only those are enumerated which interfere with the growth of forage crops. Even some of these are valuable forage plants in themselves, but they are listed here because of their persistency or their frequent occurrence in ground sown to other forage crops or in localities which, were it not for their presence, would yield more valuable feed.

The number of plants recorded in this connection might be greatly extended by accepting a more liberal interpretation of the meaning of weed and by an enumeration of the less harmful ones. Such plants as wire grass (*Juncus balticus*), which produces a very poor quality of hay, mint (*Mentha canadensis*), and heliotrope (*Heliotropium curassavicum*) grow in great profusion, but they develop only in places and under circumstances where nothing else will grow. They therefore serve the useful purpose of furnishing a soil cover after the flood water disappears, and some of them even furnish a poor quality of feed. The plants which interfere in native meadows are few compared with those which are troublesome in alfalfa meadows. Here under the stimulus of too superficial cultivation they receive a great impetus, and, under unfavorable conditions for the development of the cultivated crop they interfere with its growth and very materially reduce the value of the hay and the pasture.

Death weed (*Iva axillaris*).—This is undoubtedly one of the most persistent weeds in northern Nevada and southern Oregon. It grows very profusely in low alkaline meadows and pastures. In many places where pasturing has been carried to excess it forms a complete covering for the ground, and often, as was the case on large areas in the Quinn River Valley, no other plants grew with it. It is also at times a very bad weed in cultivated lands, and in such cases interferes very materially with the crop. Its habit of propagation by creeping rootstocks renders it a very difficult plant to eradicate. With thorough cultivation, however, no serious apprehension need be had concerning it, as in ground thoroughly plowed and cultivated each year it soon disappears. It gives the greatest amount of trouble in land which is only partially subdued, such as the lower sage-brush areas. In this region of scanty rainfall, where alfalfa is about the only cultivated crop raised, and where it is by far the best paying crop, the rancher is liable not to thoroughly prepare the ground for its reception. Very often a sage-brush area is cleared up and sown to alfalfa with no other crop preceding it. In such cases, as will readily be seen, the ground is not thoroughly prepared, and this weed as well as many others will persist in the soil to the detriment of the crop for several years.

Sunflower (*Helianthus annuus*).—This widely distributed weed frequently interferes very materially with the development of the forage crops, especially in the newly broken bottom lands or rebroken pastures and meadows. Its development was especially abundant on the ranch of J. S. Divine, also in certain localities on the Malheur Lake bottoms. On Mr. Divine's ranch it, together with the horsetail spoken of below, formed about one-third of the crop of grain hay.

Horsetail (*Equisetum robustum*).—This is often pointed out as a vile weed, but it seldom does much damage where land is properly treated. In localities where it was noticed this year the land had been overirrigated and poorly cultivated.

Blue flag (*Iris missouriensis*).—Large areas of this are found in the mountain

meadows and especially in depressions and "draws," which furnish large quantities of feed, consisting of native clovers and sedges. It seems never to be eaten by either cattle or sheep, and forms a very conspicuous weed in the localities mentioned.

MUSTARD (*Sophia pinnata*).—In southern Oregon this appeared to be the worst weed in alfalfa meadows. At Denio the alfalfa hay with which our horses were fed at the livery stable consisted of at least one-half of this plant. While this was the worst case seen, it was very commonly found in large quantities in the alfalfa hay throughout the region. To the north and south of this place, however, less of it was observed.

LETTUCE (*Lactuca scariola*).—This was not prominent enough to attract any attention until we reached the headwaters of the Malheur River. From here on to Ontario it steadily increased in quantity. It was especially abundant in alfalfa meadows in the lower course of the Malheur River. Several fields were seen in the vicinity of Vail, in which this plant grew about as thick as it could well stand and as high as one's head.

WILD OATS (*Avena fatua*).—This, like the previous species, attracted no attention until we reached the headwaters of the Malheur River. It was common, however, all along the trip, but not of so much consequence in this region as where small grains are grown. There may be large quantities of it in alfalfa fields, but it is usually cut at such a time as to make very good feed, and thus every cutting tends to clear the land of it. In as much as alfalfa is cut often the oat does not have time to mature its seed.

SQUIRREL TAIL (*Hordeum jubatum*).—This is probably the most persistent and troublesome weed which inhabits native meadows. When it occurs, as is often the case, in hay land, the quality of the feed is very decidedly reduced by its presence. In this condition it is not relished by stock, and when forced to eat it they often become emaciated and their mouths become sore on account of the accumulation of the beards between the teeth. However, as stated elsewhere, it is not wholly a weed, for it often forms, with proper management, a very palatable and nutritious pasture or hay ration.

BARNYARD-GRASS (*Panicum crus-galli*).—In but one locality was this found in any quantity which attracted attention. Here there was a phenomenal growth of it. On the Harper ranch, on the Malheur River about 40 miles above Ontario, a large field of alfalfa, seeded last spring, contained a remarkable volunteer crop of this grass mixed with it. It was very noticeable, however, that it developed in the lower portions of the meadow in which the water from the two irrigations applied accumulated and remained for sometime before soaking into the ground. In this area, particularly, there was a growth of at least two tons of hay per acre. As would be expected, the alfalfa was completely killed out, due, in all probability, not to the presence of the weed, but to overirrigation and improper drainage. (See Pl. XVI, fig. 1.)

UTAH SALTBUSH (*Atriplex truncata*).—This, like the two following species, often grows in great quantities in low, poorly drained, alkaline, alfalfa meadows. It was especially abundant in such localities near Beulah, on the north fork of the Malheur River.

HALBERT-LEAVED SALTBUSH (*Atriplex hastata*).—Much of this species is often cut with alfalfa and also with native forage plants. It is questionable whether it ever interferes very materially in alfalfa meadows, although large patches of it frequently occur. It usually develops in situations which are either too alkaline or too poorly drained for the former.

PAHUTE WEED (*Dondia depressa erecta*).—This plant, which is said to receive its name from the fact that the Pahute Indians used the seed for food, is a weed in the same sense as are the two previous ones, and the notes under those species apply equally well here.

WHITE SWEET CLOVER (*Melilotus alba*).—This weed, so common in nearly all irrigated regions, is very abundant northward. It does not appear to find congenial conditions in the southern portion of the Territory, but is especially unsightly along irrigation ditches in the drainage of the Malheur River.

POISONOUS PLANTS.

There is in this region as in all other grazing areas a very vague and indefinite idea regarding this class of plants. One will often find valuable forage plants pointed out as injurious to stock and passing under the vague term of "loco weeds." The prejudice against a certain plant often arises from some circumstance connected with the behavior of cattle in the vicinities where it grows in abundance. Cattle die for an unknown reason and the most natural thing to attribute the malady to is the poisonous effect of some plant. It has appeared, on this trip as well as on others in range States, that there is much popular misconception in reference to the matter. Usually it is difficult to obtain definite information concerning authentic cases of injury to stock from eating the plants in question. When one takes cognizance of the numerous species which are considered poisonous and then follows up the sheep camps or studies closely pastured meadows for a few days, he is sure to lose confidence in much of the popular belief concerning the poisonous effect of plants. There are two species, however, in this region which are universally condemned, and there is strong evidence that they do much injury at certain seasons of the year. As far as we were able to learn there was no injury from either except in the early spring.

LARKSPUR (*Delphinum scopulorum*).—According to the account given by Mr. F. C. Lusk, superintendent of the French-Glenn estate, this plant is one of the first to put forth a vigorous growth in the spring. When the ground is still moist, the cattle pull up the tuberous roots and eat them along with the succulent tops. He reports that there are no prominent symptoms following the feeding on this plant, and that the cattle simply "lay down and die." This account has been repeated substantially by other observers in the region, so that it appears to be well authenticated. While the plant appeared to be common enough in the mountains where we traveled, it was only in two or three localities that it was conspicuous. It is said to be more noticeable in the spring on account of its early appearance when there is less vegetation on the ground. The stock at this time of the year, after having been confined to dry, dead, and very short pasture grasses of the lowland meadows during the winter, are, of course, very eager for green feed and consequently eat many things which they would not touch later in the season when feed becomes more plentiful.

Attention is called here to the fact that injury from this plant, as well as the next one mentioned, occurs when cattle are first turned onto the range from short pastures or short hay rations during a long and often hard winter. They often go out in spring in a condition of very low vitality. It is suggested that the large death rate at this season may to a large extent be due to the radical change of ration at a time when the general tone of the system, owing to impoverishment and change of season, is least able to withstand such changes. The fact that at times cattle die in large numbers at this season of the year, when the system is least able to withstand the effect of noxious weeds or other injurious agencies, would tend strongly to create

a suspicion that the condition of the animals acts as a very potent factor in causing the numerous losses.

WILD PARSNIP.—At least two plants designated by this common name are universally condemned. They are both very common in the lowland meadows and pastures in both northern Nevada and southeastern Oregon. These are known to botanists as *Sium cicutifolium* and *Cicuta vagans*. Large quantities were cut with hay at Winnemucca and Quinn River Crossing, Nev., and on the White Horse Ranch, near old Fort Smith, Oreg. No complaints are expressed against them in this condition. Like the larkspur, they appear to be injurious in the spring when the ground is moist and the cattle are able to pull up and eat the roots. In this instance again the injury occurs at the time when the cattle are in an impoverished condition and therefore least able to withstand the effects of any deleterious agents. Mr. Lusk reports that his company has paid out considerable money in attempting to eradicate this weed. It hires Indians or other cheap labor to dig up the plants in much the same way that the dandelion and the thistle are removed from lawns in the East.

FORAGE PLANTS.

No attempt is made to give a complete list of the forage plants of the region, even so far as observed on the trip. This would evidently include all of the grasses, sedges, and rushes, and would unduly extend the appended list to no purpose. Indeed, many of the plants collected which are known to be eaten by stock are purposely omitted from the list, either because they grow in quantities too small to be taken into account, or because they are not considered of sufficient importance to be noted.

THE TRUE SAGES.

The sages as popularly recognized constitute a very heterogeneous group of plants. A rough classification is frequently made, however, by the rancher into black sage and salt sage. The group included under the above head constitutes those shrubby plants belonging to the genus *Artemisia*, which bloom late in autumn and produce very inconspicuous flowers and seeds which are very seldom seen by the ordinary observer. They differ from the next group—the salt sages—in having a very bitter taste and a very penetrating odor, like the common wormwood to which they are closely related. They grow in those situations which although arid are seldom alkaline. The abode of the conspicuous and most valuable ones is therefore above the basins and river bottoms, on the mesas and in the foothills. The different species differ greatly in their forage value, depending presumably upon the quantity of the bitter principle present in the leaves and twigs.

BLACK SAGE (*Artemisia arbuscula*).—This sagebrush is the typical mountain form and differs mainly from the common black sage of the mesas (*A. tridentata*) in having larger flowers and more spreading scraggly branches. What is said concerning the feeding value of *A. tridentata* will apply with equal force to this species. Another species, which is closely related to the above and which is very common on the mesas

FIG. 1.—A TYPICAL NORTHERN NEVADA RANCH, QUINN RIVER CROSSING.

FIG. 2.—DIVINE'S RANCH, EASTERN BASE OF STEINS MOUNTAINS, OREGON.

of the western Dakotas, portions of Wyoming, Montana, and Colorado, was found in one locality in Steins Mountains, where it covered quite extensive areas. This species, known to botanists as *A. cana*, differs from the preceding in having a more erect habit of growth and longer entire leaves. Its feeding qualities differ in no wise from those of the next species. (See Pl. VI, fig. 1.)

Black sage (*Artemisia tridentata*).—This is the common sage of the mesas and foothills. It takes the place of the Cactaceæ and the creosote bush (*Larrea mexicana*) of the deserts to the southward. Its feeding qualities are very inferior. It is sometimes said to be used for feed to a considerable extent, but its value is probably overestimated. According to the best information we are able to obtain, it is seldom browsed, even by sheep, excepting in extreme cases, and then it is claimed by the sheepmen of the region that the animals can not live upon it for more than a couple of days at a time. (See Pl. II, fig. 2.)

Black sage (*Artemisia rigida*).—This was met with in but two situations, the first near the Calamity settlement and the next near Westfall, Oreg. In both instances it was cropped very closely and it was with the greatest difficulty that we were able to secure specimens enough to identify the plant, inasmuch as we were unfamiliar with it, having never seen it growing before. Pl. III, fig. 2, shows this plant as it appeared near Westfall. The bunches in the foreground constitute what remains of the plant after being fed off during the winter months. In the background, both in front of and behind the wagon, will be seen a typical growth of the common black sage (*A. tridentata*).

Mugwort (*Artemisia ludoviciana*).—A very common species of sage growing in general in higher nonalkaline lowland meadows. It is said to be pastured to a large extent in the winter, and very much of it is cut with other forage plants for hay. In this way it forms quite an important factor in the winter rations. It is probably relished much more by sheep than by cattle.

Bud sage (*Artemisia spinescens*).—A spiny, straggly shrub which blooms early in the spring and drops its seeds and leaves in midsummer, becoming almost, if not quite, naked by the middle of August. Of all the species of true sages that grow in the region this is undoubtedly the most important. It is said to be browsed by cattle as well as by sheep. As we saw it between Winnemucca, Nev., and the Alvord desert in Oregon, where it was exceedingly abundant on the foothills and high mesas, it invariably bore evidences of having been browsed during the past season. It is to be understood, of course, that this as well as the other species of the true sages are not eaten during the summer.

THE SALT SAGES AND THEIR ALLIES.

This group of usually salt-loving plants is of great economic importance in all the plains and basin region. Some of them form the main winter feed in many situations, while others, like the true sages, may be considered plants which form a subsistence ration. They vary greatly in the character of soil upon which they thrive, some, such as the common greasewood, being seldom found except on soils which are too alkaline for almost all other kinds of vegetation, while others, such as white sage and the spiny salt bush, probably never grow on what may be termed alkaline soil. All these plants belong to the goosefoot family, although they differ widely in their general appearance. They may be readily distinguished from the true sages by their more prominent fruits, winged seeds (fruiting bracts), and salty rather than bitter

taste. Some species are annuals, but the majority of those which are most valued as forage are shrubby perennials.

SILVERY SALT BUSH (*Atriplex argentea*).—A bushy, branched, triangular leaved annual which develops in unsodded areas in native meadows and often in poorly cultivated fields on the lower elevations. In the latter situation it receives a stimulus from artificial cultivation and often makes a good stand. Much of it is cut with hay and is readily eaten by both sheep and cattle.

SHAD SCALE (*Atriplex canescens*).—A bushy, branching shrub, 3 to 10 feet high. It is most abundant in northern Nevada, where it grows commonly in the sandy stretches bordering low areas. It is less abundant and therefore of less consequence in this region than the next species mentioned, but it is probably relished more by stock.

SPINY SALT BUSH (*Atriplex confertifolia*).—A diffusely branched spiny shrub, 1 to 3 feet high, growing in nonalkaline situations on the mesas and foothills. Its habits are about the same as the bud sage, with which it often forms the only vegetation on large areas of the lower foothills between the draws where the black sage predominates. It is undoubtedly one of the most important winter feeds for sheep in the entire region, since the white and red sages have become so much reduced by overstocking.

HALBERT-LEAVED SALT BUSH (*Atriplex hastata*).—This is a branched, erect annual, growing in rather alkaline situations and having about the same value and habit as *A. truncata* and *A. argentea*. Like these two species, it sometimes develops tremendously in cultivated fields, in spots where the soil is too salty for the development of alfalfa and other cultivated crops. It often forms an almost pure crop in local areas in native meadows. In either case it is often gathered with the hay in considerable quantities and eaten by stock in winter. On the range it and the two species mentioned above are pastured to a large extent. These three species were especially abundant on the north fork of the Malheur River above Beulah, Oreg., and were common in hay meadows all the way from Winnemucca north.

NUTTALL'S SALT BUSH (*Atriplex nuttallii*).—A low spreading, sparingly branched shrub. This species was not seen until we reached the Malheur Lake basin, where it was found over large areas. It was again encountered in great abundance in the valley of the Malheur River, about 40 miles above Ontario. Wherever it was found it was invariably closely grazed on the open range. Pl. III, fig. 1, shows an area of this plant on the open range near the Harper ranch. All of the vegetation in the foreground, excepting the bunch of cactus, consists of stumps of this shrub. On the Harper Ranch there was one field which contained large areas which were protected during the summer. These areas invariably contained nothing but this season's growth of a few branches 6 to 12 inches long, showing how greedily the plant is eaten by cattle during the winter.

TORREY'S SALTBUSH (*Atriplex torreyi*).—A tall, diffusely, and rigidly branched shrub, 4 to 8 feet high, with triangular leaves, angular branches, and long, tapering spines. It was met with only in a few localities in northern Nevada, as far north as Quinn River Crossing. In the vicinity of Winnemucca it was browsed to about the same extent as the shad scale.

UTAH SALTBUSH (*Atriplex truncata*).—An erect, sparingly-branched annual, resembling silvery saltbush in general appearance and habit. Like the halbert-leaved saltbush, it often forms a large part of the hay cut on the native meadows, and develops to almost an alarming extent in cultivated fields which are inclined to be too salty for ordinary crops.

PAHUTE WEEDS (*Dondia depressa erectia* and *D. diffusa*).—Both of these plants are much branched, narrow-leaved annuals, or, at most, biennials. The common name by which they are designated in this region is said to be derived from the fact that the

Pahute Indians were in the habit of collecting the seed and using it for food. The plants are of rather questionable forage utility, although said by some to be relished by cattle after the late autumn frosts. Like the last species of saltbush, these often grow very vigorously in cultivated fields which are slightly too alkaline for cultivated crops.

Hop sage (*Grayia spinosa*).—A well branched shrub, 1 to 3 feet high, with long, slender spines, thick, rather succulent leaves, and a spike of winged fruits which bear some resemblance to the cultivated hop from which is derived the common name. This is seldom eaten in summer, but in the winter the leaves and fruit which fall in late summer are picked up by stock in much the same manner as they eat the leaves of the mesquite further south on the Arizona deserts. It grows in situations similar to the spiny saltbush, and is of value as autumn and winter feed.

White sage (*Eurotia lanata*).—As it grows in this region at the present time this is a low shrub, one-half to 2 feet high, consisting of a few straight unbranched shoots from a woody stump. It was formerly of much importance as a winter feed for both cattle and sheep, but the quantity is so reduced at the present time that it can not be considered of much economic importance.

Red sage (*Kochia americana*).—A sparingly branched plant, one-half to 2 feet high, with straight, slender, leafy twigs. Next to the white sage this is said to be the shrub most relished by cattle of any in the region. It is quite abundant in places from the higher bottoms to the foothills. After the advent of frosts in the fall the whole plant turns red—a characteristic which has given rise to the common name. The previous year's wood always bears evidence of having been eaten.

Greasewood (*Sarcobatus vermiculatus*).—A tall, brittle, wooded shrub with spreading branches and narrow, thick, succulent leaves. It always inhabits strongly alkaline ground and often grows where nothing else but the iodine weed (*Spirostachys occidentalis*) is able to thrive. Very large areas of this are found between Winnemucca and Quinn River Crossing. It is really the prominent lowland shrub in places and does not often bear evidence of browsing, but the leaves are cleaned up off the ground where they have fallen, and it is said to furnish much feed in this way. It can, however, be considered only an emergency ration at best. The feed it furnishes is both small in quantity and poor in quality. (See Pl. XII, fig. 2).

THE CLOVERS.

One of the main differences between the meadows and river banks of this region and corresponding situations in the Dakotas, eastern Montana, and Wyoming is the presence of numerous species of clovers of great importance in the economy of the stock industry. They furnish much valuable pasture and hay of excellent quality. The most important species are discussed below, although no attempt is made to give a comple list.

Seaside clover (*Trifolium involucratum*).—This is the most abundant and important of any of the native species of the region. In the low, swampy, nonalkaline areas on the native meadows it often yields from one-half to 1¼ tons of hay per acre. On the Divine Ranch it had spread, under the influence of irrigation, to sagebrush soil, and there, with timothy and redtop, made a fine crop. It is a promising species for cultivation and under proper treatment it would probably make feed about equal in quantity and quality to alsike clover.

Small-headed clover (*Trifolium microcephalum*).—Although not of as much importance as the previous species, this furnishes much pasture in places and it stands close grazing very well indeed. It is commonly found with the preceding species in low, wet meadows.

Beckwith clover (*Trifolium beckwithii*).—This is a larger, more rigid, and coarser plant in every way than either of the two previously mentioned. We found it at higher elevations than the others, usually in mountain valleys and meadows, along streams, and near springs. It was most abundant in portions of Silvies Valley. It is valuable mainly as a native pasture plant.

Oregon clover (*Trifolium oreganum*, No. 601).—A valuable mountain pasture plant. It is very common in mountains, where it often forms, with tufted hair grass (*Deschampsia caespitosa*) and Sandberg's blue grass (*Poa sandbergii*), a very respectable covering over the ground in small depressions and along banks of streams, and is always closely cropped in such situations.

Shield clover (*Trifolium cyathiferum*).—A common and occasionally abundant species forming much pasture along streams and moist localities. It is easily recognized by the large shield-like bracts below the heads of flowers.

THE SEDGES AND RUSHES.

When quantity alone is considered this group of plants is the most important of any in the region. Two or three species of sedges or rushes often take possession of large areas of the low, poorly drained, swampy basins and river bottoms. Although the quantity of feed from this source is large, the quality is ordinarily much inferior to that derived from the true grasses and clovers, and in some cases it is questionable whether the forage furnished by many of these plants is worth the cutting. Usually, however, the feed derived from the sedges (*Carex* sp.) is of very good quality, but on the whole rather light in weight.

Wire grass (*Juncus balticus*).—Every rancher knows this tough, wiry, leafless plant, which is almost invariably found in greater or less quantity in the lowland hay meadows. It is therefore very extensively cut for hay along with other forage plants, but it furnishes a very poor quality of feed.

Nevada rush (*Juncus nevadensis*).—This species often furnishes some pasture and a little hay along the edges of moist bottoms.

Toad rush (*Juncus bufonius*).—A low-spreading, much-branched plant growing in edges of ponds and very wet places. It is often pastured where better feed is scarce.

Creeping spike rush (*Eleocharis palustris*).—This is also often referred to as wire grass. It is very abundant on all of the lower meadows, and, like the wire grass, is often cut for hay. It is neither so harsh nor so rigid as the latter. Nowhere on the trip were such areas of it encountered as on the Malheur Lake bottoms, where much of it was cut along with other crops.

Awned cyperus (*Cyperus aristatus*).—This is quite abundant on sandy banks of the tributaries of the Malheur River, where it furnishes some pasture, but never any hay.

Red-rooted cyperus (*Cyperus erythrorhizos*).—This is often found in hay in considerable quantities on the low, wet, nonalkaline meadows along streams in southeastern Oregon.

Tule (*Scirpus lacustris*).—This is the most conspicuous plant on the bottoms. It often grows to a height of 15 feet, and the culms are often three-fourths of an inch in diameter. Pl. XV, fig. 2, shows this plant as it grows over very extensive areas on the Malheur Lake bottoms. In the more moist areas it is used simply as a browse and shelter for cattle during storms, but in the edges of the lower areas, where it grows to a height of 1 to 4 feet, much of it is cut with other hay crops, with which it is mixed. The quantity of feed from this source is probably

FIG. 1.—A PART OF A DAY'S ROUND-UP OF BEEF, SILVIES VALLEY, OREGON.
Smoke from a forest fire shown along the horizon.

FIG. 2.—A WELL-DEVELOPED GREASEWOOD BUSH NEAR WINNEMUCCA, NEV.

considerable, but the quality is very poor. The seeds are nutritious, and one may often see horses in the tule patches in late summer picking off the heads.

Prairie bulrush (*Scirpus campestris*).—A brown-headed, triangular-stemmed, large, coarse, grass-like plant, growing in low, wet, and often alkaline meadows. The quantity of forage yielded by it is very large, and the quality, while not as good as that furnished by the grasses, is still very fair. Closely related species furnish large quantities of hay in many localities on lake and river bottoms in the Dakotas. In the vicinity of Divine's ranch, at the edge of the Alvord Desert, there was a very fine growth of this rush. Pl. VII, fig. 1, shows a very ordinary development of it, and also something regarding the character of the soil on which it grows. This particular spot would cut one and three-fourths to two tons per acre. In some places in this vicinity hay consisting of about two-thirds of this rush and one-third tule was cut in large quantities. The yield was often three tons per acre of very bulky forage.

Small-seeded bulrush (*Scirpus microcarpus*).—This is frequently found in large quantities in low, wet, nonalkaline areas. It is never in such quantities nor in such situations that it can be cut for hay, but it forms much of both winter and summer pasturage. It was first met with in the vicinity of Pine Forest Mountains, and frequently from there north.

Three-square (*Scirpus pungens*).—A triangular stemmed plant, with a small lateral head and few leaves, growing thinly, and propagating by creeping root stocks in wet and often alkaline localities. The same species is very commonly found in considerable quantities in the hay meadows in Wyoming, Montana, and the Dakotas. It is cut and pastured, but it makes a quality of feed but little better than the tule.

Awned sedge (*Carex aristata*).—This sedge furnished a great deal of pasturage and feed on the Malheur Lake bottoms. It grows in rich, moist, nonalkaline areas to the extent of one and a half to two tons per acre. Where we saw it the individual areas in which it grew were not large, but frequent, and measured from one-fourth to three or four acres. It furnishes by far the best and largest quantity of hay of any of the sedges in this region.

Douglas sedge (*Carex douglasii*).—This conspicuous, yellow-headed, wiry plant is probably the most common of all the species of the sedge family. It is invariably found on the drier bottoms, where it grows oftentimes to a height of 8 inches. Much of it, therefore, gets into the haystack, where it is readily eaten in winter, although it is very tough and wiry. On the open range it is always closely grazed. Its main value is for pasture.

Gay's sedge (*Carex gayana*).—This often forms from one-fourth to one-third of the hay in some localities. It was decidedly abundant in the vicinity of the Alvoid Desert, where, together with the Nebraska sedge and seaside clover, it yielded about one and a half tons per acre. Nowhere else was it found in such abundance.

Woolly sedge (*Carex lanuginosa*).—Commonly found mixed with the tule, but it thrives best in soils immediately surrounding the latter. It very often grows in situations too wet to be cut, but even here it furnishes feed for winter pasture. On the lower wet meadows on the Divine Ranch it formed about two-thirds of the crop over very large areas, the remainder being furnished by the Nebraska sedge and the seaside clover. It is also an important factor in the hay supply on both the Quinn River Crossing and White Horse ranches.

Clustered field sedge (*Carex marcida*).—Two varieties of this species are common in northern Nevada and southern Oregon. They are never abundant enough to form any great amount of hay in any one place, but in the aggregate, over large areas of the drier meadows, they amount to a great deal. When the drier meadows are too short to cut it is pastured in the winter with other sedges and grasses.

Nebraska sedge (*Carex nebraskensis*).—A very valuable pale-green species growing

in low situations which are covered with water until late in the season. The hay which it furnishes is rather light, but usually considered of fair quality for this class of plants. It may grow alone over considerable areas which dry in midsummer and bake very hard, or it may be found with other closely related species and some clovers. The latter, of course, very materially improve the quality of the hay. (See also under Gay's sedge and Woolly sedge).

Soft-leaved sedge (*Carex tenella*).—This slender-culmed species furnishes a great deal of pasture in shady places in the mountains.

Bottle sedge (*Carex utriculata*).—Common in moist meadows, where it is both pastured and cut for hay. It was not collected in Nevada but was of considerable importance on the meadows of Silvies Valley and the north fork of the Malheur River, near Beulah, Oreg.

MISCELLANEOUS.

Horkelia fusca.—This glandular, strong-scented plant with numerous compound root leaves is an important sheep plant. It is very abundant in Steins Mountains and almost invariably bears evidence of being grazed. Cattle, however, in all probability never touch it.

Prairie vetchlings (*Lathyrus decaphyllus* and *L. Oregonensis*).—Grow very profusely in some localities and are to some extent found in hay in the Alvord Desert basin. We saw no evidences of their being pastured, however.

Dakota lotus (*Lotus americana*).—This plant, so abundant on all the river bottoms and low prairies in the Plains region, was not encountered until we reached the Snake River at Ontario, Oreg. Here it was very abundant and bore evidence of being grazed in many of the poorer pastures. It is very seldom indeed that the writer has seen this condition. Usually it, like the lupines, remains untouched in pastures, although readily eaten in hay.

Lupines.—These conspicuous blue-flowered plants, belonging to the pea family, are very numerous and characteristic of the western plains, mountains, and even deserts. They are usually considered of some value, and are therefore included here. It has not been the writer's experience, however, that they are eaten much by cattle. Sheep occasionally do eat them in poor pastures, but their destruction by the sheep is due more to trampling than to actual eating. About ten species were collected, two or three of which are very common, and might be mentioned in a list of forage plants. The most important are *Lupinus lepedus* and *Lupinus laxiflorus*.

Bur-reed (*Sparganum eurycarpum*).—A broad-leaved grass-like plant with prominent globular masses of fruit produced in late summer. This very common plant in all the wet meadows of the regions is of more economic value here than in any locality the writer has ever visited. It is often cut with the tule, sedges, and rushes for hay, and is commonly pastured where stock can get at it during the summer. It was especially abundant on the Malheur Lake bottoms where pure growths of it were often found. The team in Pl. XV, fig. 2, is standing in an area of this plant.

Seaside arrow grass (*Triglochin maritima*).—This salt-loving plant, with rush-like leaves and stout, erect, naked flower stalks, furnishes much pasture and occasionally a little hay along with the more valuable rushes and sedges. It is found only in very moist alkaline regions, and is an invariable occupant of the saline regions in the vicinity of hot springs.

Cat-tail (*Typhia latifolia*).—This conspicuous and universally recognized swamp-land plant furnishes much winter feed, and occasionally some of it is cut for hay. A little of it is shown in the extreme foreground in Pl. XV, fig. 1.

American vetch (*Vicia americana* and *V. truncata*).—Are common and of some value on portions of the drier, rich, lowland meadows. Like the vetchlings discussed above, they are not pastured except where the sedges, grasses, and clovers fail.

FIG. 1.—A MODERATELY GRAZED NATIVE PASTURE IN STEINS MOUNTAINS, OREGON.
Stubble of sheep fescue constitutes nearly the entire vegetation in foreground.

FIG. 2.—A GIANT RYEGRASS MEADOW, QUINN RIVER CROSSING, NEVADA.

Alfilaria (*Erodium cicutarium*).—This forage plant, which is of so much importance on many of the Arizona and California arid pastures, was seen in considerable quantity along the western base of the Pine Forest Mountains in Nevada and at Denio, Oreg., but it is very doubtful whether it is abundant enough to be of much value.

THE GRASSES.

Short-leaved wheat grass (*Agropyron brevifolium*).—Occasional in Steins Mountains.

Awned wheat grass (*Agropyron caninum pubescens*).—A common species in the mountains. It forms some pasture at moderate elevations, especially in the Pine Forest Mountains.

Western wheat grass (*Agropyron occidentale*).—This forms a scattering growth in the lower sage-brush areas. It seldom, if ever, grows on the lower alkaline soils. It is of very little importance here compared with the plains region. The variety *molle* grows in similar localities.

Western couch grass (*Agropyron pseudorepens*).—Common in the rich, drier meadows, but never forming the quantity of feed that it does east of the Rocky Mountains.

Bunch wheat grass (*Agropyron spicatum*).—This is the most important wheat grass of the region. It is an awned grass, and grows almost invariably in rocky but fertile soils in the upper foothills and mountains. Although rather harsh and wiry, it furnishes much valuable feed for summer and autumn pasture.

Slender wheat grass (*Agropyron tenerum*).—Although common on the richer, well-drained lowland areas throughout the region and of some importance as a pasture and hay grass, it amounts to but little compared with the plains region, where it furnishes such magnificent pasturage and hay.

Water foxtail (*Alopecurus geniculatus*).—A low, smooth, tender grass with weak stems, which often root at the joints. It is found abundantly throughout the region, along streams, and in wet meadows which are not completely sodded over with the sedges. It furnishes good pasturage, but the quantity of hay is of little consequence.

Redtop (*Agrostis alba*).—Doubtless some forms of this widely distributed and valuable forage plant are indigenous, but it is so widely distributed in all meadows that the introduced form often appears native. It is well adapted to the poorly drained, boggy areas, and it is believed that it could be more extensively introduced with great profit.

Rough hair grass (*Agrostis hyemalis*).—A slender, smooth grass with delicate panicle, furnishing some pasture in moist mountain meadows, as well as upon the lowlands. The quantity of its hay is small, but the quality good. On the low meadows of the White Horse Ranch much of it was found in the hay. Probably as high as a fifteenth of the entire bulk consisted of this grass in limited localities.

White top (*Agrostis exarata grandis*).—An erect, smooth, rather tall grass, growing usually in loose bunches. It is of much value for both pasturage and hay and is relished by all stock. It is never abundant enough to make a crop itself, but it often forms an eighth or tenth of the bulk of the forage on the low meadows.

Slender bent grass (*Agrostis variabilis*).—A tufted, slender mountain species which furnishes much pasture in moist meadows. It was especially abundant in Steins Mountains, where it often furnished good feed in rather dry localities. It is always more or less abundant in all the depressions and along streams.

Purple bent-grass (*Agrostis humilis*).—A slender, purple-topped, tufted species, growing in moist places in mountains. It furnishes some feed in the vicinity of streams and lakes in the Pine Forest Mountains.

HALL'S REDTOP (*Agrostis hallii*).—An erect grass, resembling closely the common redtop, but with a more open and delicate panicle. It is a valuable hay grass in the Alvord Desert region, especially on the White Horse and Divine ranches. In some meadows on the former it replaces to a very large extent the common species of redtop, and forms, in limited areas, a fourth of the crop of hay, the remainder being made up of seaside clover and several sedges.

WILD OATS (*Avena fatua*).—This grass, which is such a pest in many small grain-growing regions, has been mentioned under weeds. Several fields of first and second crop alfalfa were seen in which this formed a third to a fourth of the forage. One or two years of alfalfa cropping will usually rid the land of it, however.

SLOUGH GRASS (*Beckmannia erucæformis*).—A common species all through the region, but never abundant enough to be of any importance as a hay plant, as it is oftentimes in western Montana, especially in the Flat Head Valley. Here it forms simply a scattering growth in moist places along ditches and streams, and is of value only as a pasture grass.

KEELED BROME (*Bromus carinatus*).—A stout, erect, tufted, perennial grass, abundant in all the mountain regions. It usually grows in steep, rocky places with bunch wheat grass, Buckley's blue grass, and sheep fescue, and forms large quantities of feed in such localities. It is especially abundant in Steins Mountains on the side of Teger and Blitzen gorges.

SHORT AWNED BROME (*Bromus marginatus*).—This species, although extending into the mountains, makes its best growth in partially cultivated ground on the lower levels. At Big Creek and about 10 miles south of Burns there were exceptionally fine growths of it in many fields. It is the most promising of the native species of this genus for cultivation.

HAIRY BROME (*Bromus subvelutinus* No. 617).—This strikingly hairy species was found in only one locality, but there it formed about a sixth of the entire pasture growth, the remainder being Buckley's blue grass and bunch wheat grass. The locality was a southern, rocky exposure in Steins Mountains, about one-half mile below the gorge on the Blitzen.

INTRODUCED SPECIES OF BROMES.—Four species not native to this country are introduced in this region in considerable quantity. In limited localities these vie in importance with the native grasses, and wherever found they are valuable forage either as hay or pasture. Usually, however, they assume the character of weeds. The most common of these forms is, of course, the common cheat (*Bromus secalinus*). The appearance of three species of this genus along Bartlett Creek in northern Nevada was very interesting. There had been some prospecting in the valley and seeds of *Bromus rubens*, *Bromus hordeaceous*, and cheat (*Bromus secalinus*) had evidently been introduced with feed from California points. These species had literally taken possession in some portions of the valley. Being annual species, however, they dry up early in the summer and are then not relished by stock.

YELLOW FOX TAIL (*Chætochloa glauca*) and GREEN FOX TAIL (*Chætochloa viridis*).—Are sparingly introduced. Nowhere did we see them thriving with any degree of vigor.

BLUE JOINT (*Calamagrostis canadensis acuminata*).—Occasional on low, moist meadows. It is never very abundant, but makes good feed wherever found.

YELLOW TOP (*Calamagrostis hyperborea americana*).—A very important, erect, rather wiry grass. Yellow top grows well on low, moist meadows. The best growth of it the writer has ever seen was on the Malheur Lake bottoms, where there were areas of an acre or more in places almost pure. It was always found along the edges of the lower bottoms and, according to soil tests, in nonalkaline soil. A large quantity of seed was secured from the Island Ranch, south of Burns, Oreg.

TUFTED HAIR GRASS (*Deschampsia cæspitosa*).—This is an important forage in the moister localities in all the mountain ranges. It stands close pasturing very well,

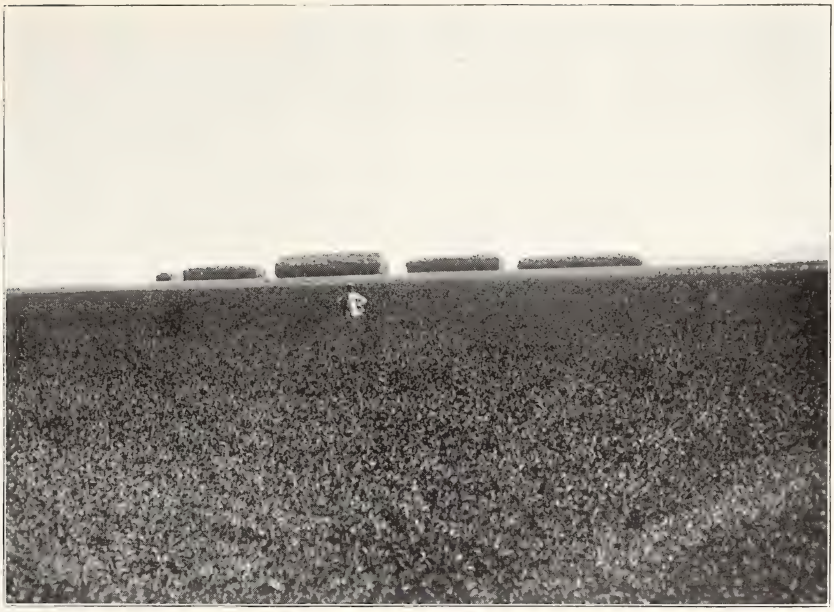

FIG. 1.—FOUR WEEKS' GROWTH OF SECOND-CROP ALFALFA, NEAR ONTARIO, OREGON.
Field said to have produced 10 tons of hay on three cuttings last year.

FIG. 2.—WILD WHEAT NEAR WINNEMUCCA, NEVADA.
Closely pastured meadow of same grass in foreground.

and when kept cropped it makes a good quality of pasturage. It is also often present on the lower meadows.

Oak-like hair grass (*Deschampsia calycina*).—Like the last species, this has a wide habitat, ranging from the lower bottoms to the higher mountains. It was found in abundance on the White Horse Ranch, where there were acres of it. Although rather short, it had been cut for hay in places. It furnishes pasture early in the summer, but being a rapidly growing annual, it dies and dries up early in the season, and is then not relished by stock. It had all died and dried up some time before we visited the region on the 1st of August.

Slender hair grass (*Deschampsia elongata*).—Decidedly a mountain grass. While not of nearly as much importance as the tufted hair grass, it furnishes a great deal of feed in low, wet meadows, and especially in the vicinity of mountains, brooks, and springs.

Salt grass (*Distichlis spicata*).—This familiar grass on all the Western plains and basin region, while very rigid and wiry, is one of great importance. Its persistent habits of growth, its power to resist close grazing and drought, its very ordinary feeding qualities and its ability to thrive in strongly alkaline soils are qualities which make it a very valuable emergency feed. Were it not for this persistent grass many more cattle would die of starvation than do. It makes a very ordinary feed, but it is this very characteristic that makes it valuable. Were it more highly relished by stock it would probably have been exterminated long ago. It was a common thing to find it closely cropped all the way from Winnemucca to Ontario. Large herds of cattle were apparently subsisting on this and squirrel tail (*Hordeum jubatum*) on the open range on the Malheur Lake bottoms in August.

Giant rye grass (*Elymus condensatas*).—This mammoth, erect, usually more or less tufted species is one of the most important grasses of the drier basin bottoms. There are thousands of acres of it fringing the bottom lands and often extending outward into the sagebrush areas. Pl. XIII, fig. 2, shows a characteristic growth of it in the Quinn River Valley, almost hiding a wire fence. It grows on the drier and, according to soil tests, nonalkaline areas. It is very often cut for hay, but more often it is left for winter pasture. It is very valuable in stormy weather, for its habit of growth prevents its being covered with snow. It is claimed by ranchers that it does not stand cutting and close pasturing well. Under these treatments it gets thinner and thinner and eventually disappears. The areas of it are said to have greatly diminished in recent years. Horses fare especially well on it from the middle of July to the middle of September. When allowed to pasture in the fields at this time of the year they live almost entirely on the rich seed supply, roaming over the fields and picking off the heads. Although it is often very badly ergoted, no evil effect is reported on this account.

Mountain rye grass (*Elymus glaucus*).—This abundant species of the Rocky Mountain region is common here. It grows scatteringly among the shrubbery in the mountains.

Wild wheat (*Elymus triticoides*).—This is the blue stem of this region, a name by which it is universally recognized by the ranchers. In many respects it is the most important grass of the entire region, and is a very promising species for cultivation. The seed is produced in abundance and is invariably well filled and easily gathered. Its habit of growth is very similar to that of the western wheat grass of the plains region and the quality of the hay produced by the two are probably about equal. There were magnificent crops of it along the Humboldt and Quinn rivers, in the Alvord Desert basin, and on the Malheur Lake bottoms. It grows in rich, nonalkaline, heavy soils, and where properly watered it often yields 2 to 2½ tons per acre. It appears to be well adapted to the damming and flooding system of irrigation in vogue here, for it stands submerging to a greater degree than the majority of the native grasses. Large quantities of seed were secured along the Humboldt

and Quinn River bottoms. Pl. XIV, fig. 2, shows a characteristic growth of it on the Humboldt bottoms near Winnemucca. The picture was taken from a closely cropped pasture of the same grass.

Canadian rye grass (*Elymus canadensis*).—Common and furnishing a great deal of pasture in the edges of thickets and along streams, especially to the northward.

Early bunch grass (*Eatonia obtusata*).—A valuable species wherever found, but its quantity is rather limited on these bottoms.

Indian millet (*Eriocoma cuspidata*).—A low bunch grass with white, woolly spikelets and very divergent and usually crooked, irregular panicle branches. It inhabits sandy areas skirting the river bottoms and requires a loose, porous soil for its best development. It was much more abundant in former times than it is now. The readiness with which it is eaten and the loose soil in which it grows render it very susceptible to injury from overstocking. It was pointed out to us on several occasions as having been a very valuable grass at one time, but now it is of little importance.

Creeping eragrostis (*Eragrostis hypnoides*).—A prostrate, creeping annual which furnishes some pasture in low, wet places.

Slender fescue (*Festuca octoflora*).—A small, short-leaved, annual grass which grows early in the spring, and, after maturing a large crop of seed, dies with the approach of dry weather. The species is to this region what the six weeks grass (*Bouteloua aristidoides*) is to the Arizona deserts. The latter, however, grows in July and August instead of in the spring. It is common all over the mesa region between the lowland and the higher foothills and doubtless furnishes much feed early in the season. It is usually considered of practically no value. We found it especially abundant in the lower foothills in southern Oregon.

Sheep fescue (*Festuca ovina*).—Reference has been made to this valuable mountain species in several places on previous pages. As a pasture grass it is one of the most important of the native species. It is certainly surpassed by none in either the quality or quantity of feed produced, unless it be Buckley's blue grass. It has, in this region, two well-marked and distinct forms which are as different in their habits as in their general appearance in the field. One, which is entirely smooth, occupies the areas of the mountains situated between the upper foothills and the higher elevations. In the lower portion of this area it is mixed with Buckley's blue grass, but higher up there are large areas upon which practically no other grasses grow. The other, growing on the highest elevations, is the typical glaucus form of the Rocky Mountain region. Magnificent areas of this form were seen in the vicinity of Bartlett Peak and in the Pine Forest Mountains. In the former locality there were stretches on the top of the mountains above the snowdrifts a mile in extent where there was practically no other grass. Only two small areas were found which had not been pastured.

Cut grass (*Homalocenchrus oryzoides*).—This is common on ditch banks and along streams from the Malheur Lake region north. It was not collected south of this point. It is pastured somewhat, but can not be considered of much value.

Squirrel tail grass (*Hordeum jubatum*).—Usually this species is considered a vile weed and is a great detriment to many native hay meadows of this region. But while this is true, it also furnishes a large quantity of excellent pasture in many regions. On the Malheur Lake bottoms there are thousands of acres where almost no other grass grows. On the open range it was invariably cropped close to the ground. An occasional fenced area showed wonderful stands of it. One field seen would certainly have cut a ton of this grass to the acre. The analysis of the soil samples taken from this region shows that it develops to the best advantage on soils which do not contain alkali in quantities injurious to cultivated crops; it is certainly neither so hard nor so compact as the soil in the surrounding and contiguous areas where salt grass abounds.

FIG. 1.—SPRANGLE TOP (SCOLOCHLOA FESTUCACEA) ON MALHEUR LAKE BOTTOMS, OREGON.

FIG. 2.—A PATCH OF TULE ON MALHEUR LAKE BOTTOMS, OREGON.

The team is standing in a patch of bur-reed (Sparganum).

MEADOW BARLEY (*Hordeum nodosum*).—The bearded fruits of this are probably not injurious to stock which eat it; at least no positive records are at hand of its doing any injury in this way. It enters into the composition of the hay very largely in many native meadows. Among shrubbery on the bottom it makes a very tall growth, and in such localities, where the mower can not be used, it enters largely into the composition of the winter pastures.

SEASIDE BARLEY (*Hordeum maritimum*) and WALL BARLEY (*Hordeum murinum*) are shorter lived than the other two species and are therefore of less value. They furnish some pasture early in the season, but usually are as little prized as the slender fescue.

PRAIRIE JUNE GRASS (*Koleria cristata*).—This is distinctly a mountain grass in this region. It usually grows to best advantage in the rich soils of rocky gulch sides, where it often forms from one-eighth to one-sixth of the pasturage.

BULBOUS MELIC GRASS (*Melica bella*).—A very common species with a bulbous base resembling that of the common cultivated timothy. It is never very abundant, but grows rather sparingly among mountain shrubbery, where it furnishes good, although limited, pasturage.

MUHLENBERGIAS (*Muhlenbergia comata* and *M. sylvatica*).—Common along streams in protected places and along irrigating ditches, and furnish a limited quantity of pasturage.

REED MEADOW GRASS (*Panicularia americana*).—A swamp-land species which occasionally furnishes a little hay, but which is of most value as a pasture grass. It is abundant along the Malheur River and its tributaries.

MANNA GRASS (*Panicularia pauciflora*).—More of a mountain form than the former species. It is always present in wet, rich soil, along streams. In the White Horse and Pine Forest mountains it was especially abundant.

BARNYARD GRASS (*Panicum crus-galli* and the variety *muticum*).—While common in wet and waste places all through the region, it was nowhere so abundant as on the Harper ranch, 40 miles above Ontario, Oreg., on the Malheur River. It was considered a bad weed here because it had taken possession of a first-year field of alfalfa. Pl. XVI, fig. 1, shows a volunteer crop of it in this vicinity. The failure was evidently not caused by the development of this grass, but was due in the largest measure to overirrigation, water having stood on a portion of the field for from two to five days, according to reports. This furnished just the condition necessary for the growth of this grass, and at the same time one which was fatal to the alfalfa. The lower areas in this field yielded at least 2 tons of dry hay per acre of this grass.

REED CANARY GRASS (*Phalaris arundinacea*).—A tall, handsome, lowland species, often called wild timothy. It is frequent all through the region, but apparently of little importance as a hay grass. It furnishes some pasture among the tule patches and sedges and rushes on the lower bottoms.

MOUNTAIN TIMOTHY (*Phleum alpinum*).—This is a very valuable grass, differing but little in ordinary appearance from the common cultivated species, except in size. It furnishes a great deal of pasture in the moist mountain meadows all through the region.

REED GRASS (*Phragmites vulgaris*).—This was found in but one locality, and that along Bartlett Creek, some distance up the mountains from the upper end of the Black Rock Desert.

BUCKLEY'S BLUE GRASS (*Poa buckleyana*).—This common "bunch" grass is one of the most important native pasture species. It grows from the lower foot hills to the mountains and furnishes pasture much earlier than the fescues of the higher elevations. No distinction appears to be made here between these two grasses, both the blue grasses and the fescues being designated by the term "bunch grass." It grows almost pure on the lower elevations, but higher up it is mixed with the smooth form of sheep fescue.

Bunch blue grass (*Poa laevigata*).—A smooth, erect, light-colored grass, related to the Kentucky blue grass. It inhabits the drier, nonalkaline bottoms, and is a very excellent species for both hay and pasture. The meadows of it which were seen were very uneven, due no doubt, in a large measure, to overpasturage. Many small areas on the bottoms, however, would cut one to one and a half tons per acre. The species is a very promising one for cultivation and the seed is easily gathered. The quality of both the hay and the pasturage furnished by it is excellent. The hay is much superior to that furnished by wild wheat (*Elymus triticoides*), but the yield is much smaller.

Nevada blue grass (*Poa nevadensis*).—This handsome, bunch, glaucus blue grass is confined mainly to the mountains in this region. Occasionally a little of it may be found on the lowlands, but the quantity here is very small. It furnishes much pasture on the broad, gentle slopes in Steins Mountains, as well as on the rocky, steep canyon sides.

Wood meadow grass (*Poa nemoralis*).—A common species in some mountains, but of little importance compared with the Rocky Mountain region.

Kentucky blue grass (*Poa pratensis*).—Forms of this valuable pasture and hay grass are common throughout the region from the lowlands to the high mountains. It was of greatest importance in the spur of the Blue Mountains, north of Burns, Oreg., where with Prairie June grass (*Koleria cristata*) and Nevada blue grass (*Poa nevadensis*) it formed in pine clearings in many places the entire grass forage. These three species were found here in about equal quantities.

Wheeler's blue grass (*Poa wheeleri*).—This species is often found with Buckley's blue grass in the lower mountain canyons and ravines. It furnishes excellent feed for both cattle and sheep. It was especially abundant in Steins Mountains on the sides of Teger and Blitzen gorges.

Beard grass (*Polypogon monspeliensis*).—Although an annual, this is a very important species on all lowlands. It furnishes a large amount of pasture and enters into the composition of the hay to a considerable extent. In some meadows examined it formed a fourth of the crop. The green feed is relished by stock and the hay when cut early is of good quality, though rather light. Pl. XVI, fig. 2, shows Arizona-grown plants of this species.

Alkali grasses (*Puccinellia airoides* and *P. lemmoni*).—These species are not so abundant and important in this region as one would expect. They were found all through the region, but never in such quantities as along the Yellowstone River or in the Flathead Valley in Montana. The best growth seen was near Andrews, Oreg.

Sprangle top (*Scolochloa festucacea*).—This tall, bushy-topped, broad-leaved grass was not seen except on the Malheur Lake bottoms, where it forms tremendous quantities of hay. It is a common species in low, wet meadows from Iowa to Nebraska northward, but it is not usually considered of much value as a hay grass. In certain places, however, in the general depression of the low, swampy ground in eastern South Dakota, especially in the vicinity of Clark, large quantities of hay are yielded by it in dry seasons. It is rather astonishing that it should be found again in this place in such large quantities. Quite extensive areas of it were seen which would yield three tons of hay per acre. Pl. XV, fig. 1, shows a typical area fully headed out. In the foreground it is lodged and mixed with bur-reed (*Sparganum eurycarpum*). Its habits of growth are similar to many of the valuable grasses of this and the Plains region, inasmuch as it develops by creeping rootstocks, and very often does not head out at all. This occurs in dry years and in the drier portions of the meadows in wet years. We drove through a half-mile stretch of it in one place on the Island ranch where the stand was fairly thick, 2 to 3 feet high and yielding 2 or 3 tons of hay per acre of very fair quality, although rather coarse and light. The hay being harvested as shown in Pl. VIII, fig. 2, is composed almost entirely of this grass and prairie bulrush (*Scirpus campestris*).

FIG. 1.—A VOLUNTEER CROP OF BARNYARD GRASS, HARPER RANCH, NEAR WESTFALL, OREGON.

FIG. 2.—BEARD GRASS, FROM PHOTOGRAPH OF PLANT GROWING NEAR TUCSON, ARIZONA.

Orchard barley (*Sitanion longifolium*, *S. cinerum*, and *S. hystrix*).—The first named is the most important. It is abundant all through the mountains and extends down to the upper bottoms. In regions frequented by sheep it was invariably cropped the same as other grasses. Cattle, however, do not appear to feed upon it so much. *S. cinerum* is a common species which furnishes some feed in the open clearings in the Blue Mountains, and *S. hystrix* is a mountain species which was collected only in the Pine Forest Mountains. Here, however, it appeared to be grazed fully as much as *S. longifolium*.

Small cord-grass (*Spartina gracilis*).—An erect, rigid, wiry species common on all low alkaline meadows. It is commonly found with salt grass and alkali saccaton. The little pasture which it furnishes is probably but slightly superior to the salt grass itself. We found the greatest quantity of it in the Alvord Desert basin.

Alkali saccaton (*Sporobolus airoides*).—A very characteristic and often abundant species on the low, alkaline areas. According to soil sample taken north of Denio, Oreg., it grows on the white rather than the black alkaline soil. This corresponds with observations made in Arizona. Its habit of growth in this region is very similar to the appearance it presents in the Yellowstone Valley in Montana. In the Sulphur Spring Valley in Arizona, however, it grows very often to twice the height that it does here. For a rigid, tufted grass it appears to be relished by cattle, and is always closely cropped here on the open range. In places along the Humboldt River it enters into the composition of the hay to some extent, but its habits of growth render it of more value for pasture than for hay.

Rough-leaved dropseed (*Sporobolus asperifolius*).—A short, bright green species, with long, creeping-root stocks and a delicate, divaricate panicle, which is easily broken, both in the green and ripe stages. It never forms hay, but is an important pasture grass on many of the drier meadows.

Dropseed (*Sporobolus depauperatus*).—An abundant, rather wiry, species on all of the drier bottoms. It often grows large enough to be cut for hay in favorable years, but its main value is for pasture, of which it furnishes a large amount.

Needle grass (*Stipa comata*).—This species, so abundant and important in all the plains region, grows here most commonly on the lower mesas among the sagebrush. It is never abundant enough to form even a tenth of the soil cover, but the stray, luxuriant bunches of it form feed that is highly relished by stock.

Small needle grass (*Stipa minor*).—An abundant species among shrubbery and on shady slopes, especially in Steins Mountains. It forms here much valuable pasture. It never grows thick, but, like other species which inhabit bushy localities, it grows in scattered bunches among the other vegetation.

Nelson's needle grass (*Stipa nelsoni*).—A common species in the White Horse Mountains, but never abundant enough to be of very much importance. The feed which it does produce is of good quality.

Western needle grass (*Stipa occidentalis*).—Common and conspicuous in the mountains. It grows in large bunches much like the feather bunch grass of the plains region, and the quality of its feed is very similar to the latter.

Downy oat grass (*Trisetum subspicatum*).—This furnishes a limited quantity of good pasture in the edges of thickets in Steins Mountains.

SUMMARY.

(1) The public ranges of the region are in many places badly depleted, and furnish at the present time not over one-third of the feed which they once did. This is directly traceable to overstocking, and it does not appear clear how matters will improve in this respect in the near future as long as there is no inducement for anyone to do aught but

get all he can out of the little that the country does produce. The areas of absolutely depleted range on the mountains, the most productive of any in the region and really the only grazing grounds, are rapidly increasing. The large stretches of country, especially in Steins Mountains, cleared of all semblance of forage during the past summer, will not produce as much feed next year as they did this with the same climatic conditions; and, with the present practices, which bid fair to continue, will become less and less productive each succeeding year.

In such rough mountains and stony regions no method of improvement having as its basis cultural operations are practicable. The only process of renovation and improvement of any kind that can be of utility is one that aims to control the pasturing in such a way as not to injure the stand of grass. The whole question of preservation and maintenance of native pasturage, therefore, is an administrative one. In regions which have suffered most from a lack of such administration, such as the grazing areas of the Southwest, the native grasses and other more valuable forage plants have been almost exterminated and their places supplied by weedy growths of much less value. Fortunately such transformations are slow to occur, but they are very difficultly remedied when once established.

(2) Clearing the ground of grass is not the only evil effect, as is well known. The destruction of the shrubbery, all too scanty in this region, has a potent influence on the lowland meadows and the mountains themselves, both in relation to the conservation of moisture and the protection of the surface soil from the erosive action of water. The destruction of the vegetation means vastly more than simply depriving cattle of food in the particular locality where close pasturing is practiced.

(3) The lowland meadows which yield crops of wild wheat or blue stem would, without doubt, be greatly benefited by simple cultural operations, even though no seed were sown. This grass, propagating as it does like the wheat grasses of the plains region, by means of creeping root stocks, would receive a great stimulus by having these underground stems cut at intervals, and by stirring up the ground, which becomes very hard during the summer, and is still more effectually packed by the trampling of cattle during early winter and spring. The seed of this grass, very easily collected, probably grows only to a very limited extent under present conditions, but, with light disking or harrowing, it might be used with profit to strengthen areas which have become weakened by repeated cutting and overstocking. There is no doubt that shallow disking, with a little scattering of seed of this grass, would very materially improve many of the native meadows. The areas which receive treatment would have to be very carefully selected, however. There would in all probability be very little use in

attempting to secure a stand of this grass all over the native meadows, but the areas which now produce some of this species, and formerly produced much more feed than they do now, might be greatly improved in this way. The same would apply with equal force to areas which produce bunch blue grass (*Poa lævigata*) and giant rye grass (*Elymus condensatus*), although the habits of growth of these grasses are very different. The seed of the giant rye grass is easily gathered, and, when not too badly affected by ergot, grows well. In an ordinary locality one man can gather a hundred pounds of clean seed of this grass in a day, using no other implement than an ordinary grass hook for the purpose. A vigorous man would have little difficulty in gathering fifty pounds of the seed of wild wheat in a day in at least three localities which we visited. It will be seen that this makes very cheap grass seed compared with the ordinary commercial species.

(4) Redtop (*Agrostis alba*), already established in places, could without doubt be more extensively introduced in many of the moister bottom lands. Instances have been cited where it was making a good crop, and it will without doubt grow well on the lowlands wherever the native clovers abound. It is one of the most promising plants for the improvement of portions of the bottom lands. No finer quality of hay could be desired than that which is furnished in localities at the present time by this grass and the native clovers.

(5) Mention has been made several times of the peculiar "patchy" condition of the native meadows and of the fact that the largest yield of forage is from plants which make hay of an inferior quality, such as the rushes, sedges, and wire grasses. The cause of this condition is in many cases absolutely beyond economical control at the present time. It is due largely to the effect of a too abundant supply of water in the early spring with practically none during early summer. Being located in the lower depressions in the basins, these lands can not be drained except at prohibitive prices to the majority of the holders. Where these lands can be drained without too much expense they could without doubt be made to yield more forage of a better quality than they do now. Either storing the spring flood waters and applying them later in the season or draining the low, swampy areas would produce beneficial results. Several instances of drainage on a small scale with beneficial results were called to our attention. The French-Glenn Company was installing a large dredging machine to be used in the Malheur basin when we were in the region.

(6) There are several conditions which interfere with the culture of alfalfa in this region, the first and foremost being too little water and improper methods of applying it. Other difficulties, however, are more under the control of the rancher and can usually be either avoided or obviated, namely, poor drainage and too much alkali in the soil. Usually there is an abundant supply of water in early spring, and

of course there is a temptation to use it too freely at this season, often resulting in allowing the fields or portions of them to remain flooded for three days or more at a time. In a number of instances attempts were being made to secure a stand of alfalfa on land which evidently contained considerable quantities of salt. While it has been demonstrated that, when once established, this crop will thrive in more alkali than will serve to effectually prevent germination, or at least to destroy the young seedlings, it is doubtful whether the effort to secure a stand in such land without treatment for the purpose of neutralizing the effect of the salt is warranted. The sowing of alfalfa on poorly drained land often results in disappointment. This, however, is usually of no consequence on black sage lands, for the drainage here is usually good, and whatever failures occur on such soils are due more often to improper preparation of the land, resulting in inability to properly distribute the water. In such cases some portions receive too little water, while in others it is allowed to remain long enough to destroy the crop. The latter is especially likely to occur in the spring of the year, when the flood waters are abundant and there is a liability to desire to use them as much as possible. It is doubtful whether alfalfa can be grown to the best advantage on the lower bottoms, mainly on account of poor drainage. One or two fields planted in such localities were carefully studied, and from information received concerning them it was learned that the land needed reseeding much oftener than better-drained areas. The lower bottoms are much better adapted to growing redtop and timothy.

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BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Gardens and Grounds, all of which were formerly separate divisions, and also Seed and Plant Introduction, the Arlington Experimental Farm, Tea Investigations and Experiments, and the Congressional Seed Distribution. Beginning with the date of organization of the Bureau, the independent series of bulletins of the Division of Agrostology, the last number of which was 25, and also of the other divisions were discontinued, and all are now published as one series of the Bureau.

The bulletins published in this series are:

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2. Spermatogenesis and Fecundation of Zamia. 1901.
3. Macaroni Wheats. 1901.
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5. Seeds and Plants Imported through the Section of Seed and Plant Introduction, Inventory No. 9, 4351–5500. 1902.
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